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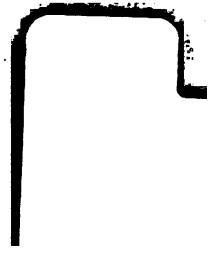

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FIFTH REPORT

OF THE

tate Entomologist and Plant Pathologist,

ON THE

SAN JOSÉ SCALE

AND THE

Administration of the Crop Pest Law

OF

VIRGINIA, 1904-05.

RICHMOND:
DAVIS BOTTOM, SUPERINTENDENT OF PUBLIC PRINTING
1906.

The Virginia State Board of Crop Pest Commissioners.

JOHN THOMPSON BROWN, *Chairman* ..... Brierfield
D. M. CLOYD ..... Dublin
W. B. ROBERTSON ..... Plasterco
J. B. WATKINS ..... Hallsboro
J. M. MCBRYDE, *ex officio* ..... Blacksburg

*WM. B. ALWOOD ..... Consulting Entomologist.
C. I. WADE ..... Secretary.

Official Staff.

J. L. PHILLIPS ..... State Entomologist and Plant Pathologist
†W. J. PHILLIPS ..... Assistant State Entomologist
‡HARPER DEAN, JR., ...
W. J. PRICE, JR., ... } Assistants
J. C. STILES .....

Offices at the Agricultural Experiment Station, Blacksburg, Va.
Address all communications to the State Entomologist.
*Resigned September, 1904.
†Resigned October, 1904.
‡Resigned April, 1905.

LETTER OF SUBMITTAL.

OFFICE OF STATE ENTOMOLOGIST AND PLANT PATHOLOGIST,
BLACKSBURG, VA., December 21, 1905.

To the State Board of Crop Pest Commissioners;

Sirs:—I beg to submit herewith the biennial report, as required by law, covering the two years from October 1st, 1903, to October 1st, 1905. I have endeavored to set forth the operations of the Commission as to both inspection work and investigations, undertaken under the Crop Pest laws of Virginia.

Respectfully submitted,
J. L. PHILLIPS,
State Entomologist and Plant Pathologist.

LETTER OF TRANSMITTAL.

To His Excellency, GOVERNOR A. J. MONTAGUE:

Sir:—I have the honor to transmit herewith the biennial report of the State Entomologist and Plant Pathologist, as required under the Crop Pest laws of Virginia. This report covers the investigations and inspection work carried on by the State Entomologist and Plant Pathologist, and his assistants, during the past two years, and the same is presented for publication in accordance with the Act of Assembly, known as the Amended Crop Pest Law, approved May 9th, 1903.

Respectfully submitted,
JOHN THOMPSON BROWN,
Chairman Virginia State Board of Crop Pest Commissioners.
Blacksburg, Va., December 21, 1905.

Fifth Report on the San Jose Scale.

AND THE ADMINISTRATION OF THE CROP PEST LAW.

INTRODUCTORY.

The reader is referred to the Third Report of the State Entomologist, issued in November, 1901, for a brief history of the San Jose scale question in this State, and a review, to that date, of legislative enactments for its suppression. Measures for control, and the general scope of the work have also been discussed quite fully in the reports from this office, and, as these matters are so fresh in the minds of persons interested in horticultural work, it does not appear necessary to discuss them further at this time.

It should be sufficient to state that, under Act of Assembly, approved May 9, 1903, $6,000.00 per year was appropriated for use in this work. In addition to this, about $2,000.00 per year has been realized from the tax placed on nurserymen who sell stock in the State. This has put the work on a financial basis, sufficient to maintain a staff whose whole time is devoted to it; and has helped very much, in the opinion of the writer, to enhance the efficiency of the work.

The act of May 9, 1903, under which this work is now being conducted, was published in a separate pamphlet, circular 32 of this office, and also in the Fourth Report of the State Entomologist. Copies of these publications will be furnished upon request.

ORGANIZATION AND SCOPE OF THE WORK.

The official staff is given on the second page of this report. The past two years (October 1, 1903, to October 1, 1905,) has witnessed a number of changes in the organization of the staff appointed to carry on this work. There has been a great demand for men to do inspection work in the different States, and four of our assistants have found employment since the last report went to press at much more remunerative salaries than those paid by this office.

The resignation of Prof. William B. Alwood, who had been retained as Consulting Entomologist, took effect September 1, 1904, at

which time he severed his connection with the college to devote his energies to private work. Mr. W. J. Phillips, the Assistant Entomologist, resigned October 1, 1904, to accept a position with the Bureau of Entomology, at Washington, D. C.; and Mr. Harper Dean, Jr., who took up the work at this time, resigned April 1, 1905, to accept the position of Assistant Field Entomologist of Georgia. Credit is due to these gentlement, in great measure, for what little of merit may be claimed for this report, as well as to their successors, Messrs. Stiles and Price, who are acting assistants at this time.

Considerable time has been devoted to the inspection of orchards, a discussion of which appears in a later section of this report. Twenty-one counties have petitioned for the enforcement of the law, and this work, with the nursery inspection, is all that can possibly be handled with the funds now available. If a thorough inspection is to be made of the fruit-growing sections of the State alone, and the law as it now stands on the statute books enforced so fully as to require the treatment of all the infested orchards, a greatly increased appropriation will be needed.

We are continuing the investigation of the crown gall of apple and the lime-sulphur wash for use against the San Jose scale. We are also studying a number of patent washes designed for use against this insect. A special report on some patent washes in comparison with the lime-sulphur wash, published in conjunction with the Virginia Experiment Station as bulletin 152, is discussed to a slight extent in a later section of this report. A partial study of the peach thrips in the nursery has also been made, a preliminary report on which is given in a later section of this report.

The reader is referred to the Fourth Report, issued in the fall of 1903, for a further discussion of the lines of work undertaken by the Crop Pest Commission.

For the financial statement, the reader is referred to later pages.

The outline given above was adhered to as nearly as possible in carrying on the work during the past two years. While much of the time of the officer in charge of this work has been required at the office, much time has been devoted to inspection of nurseries and orchards, and also the inspection of nursery stock as it is being delivered to customers.

The time devoted to nursery and orchard inspection during the two years covered by this report, is equal to practically the entire time of two men for the whole period. For this period a total of 42,260 miles of travel on the railroads of the State was required. This does not take into account the large amount of travel by livery, or the traveling done by the many local inspectors employed on the inspection work in the different counties ofthe State.

NURSERY INSPECTION.

The writer called attention in the Fourth Report to the fact that a few of the Virginia nurseries had become infested with San Jose scale during the year 1903. We feel that the fruit growers should know that during the season 1905 ten of the nurseries that had not before been known to harbor this pest, were found to be slightly infested. It is true that in all of these cases the infestation was very slight, and would not have been discovered but for a prolonged and careful inspection. These facts are not stated with a view of discrediting the work of our nurserymen, and we advise the purchase of nursery stock from State nurseries wherever it is possible. This is especially true because of the fact that we know the nurseries in a number of the other States to be in a far worse condition, as far as the San Jose scale is concerned, than those in Virginia. Besides, the men engaged in the nursery business in this State are as honorable and high-minded gentlemen as will be found in this or any other business.

Nurserymen should put forth every effort within their power to keep their plants free form this serious pest, and, should it gain entrance, every effort should be made to eradicate it.

It is true that the orchards are quite generally infested in a few localities in the State. Nurserymen should not attempt to grow stock in such localities, for no matter what location they choose at these points, their stock is likely to become infested from neighboring orchards during the two years necessary to grow it in the nursery.

INFESTED NURSERIES—HOW DEALT WITH.

As mentioned above, a few trees in 10 nurseries that had not formerly been known to harbor the San Jose scale were found the past season to be slightly infested. The same steps were taken in these nurseries to control, and, if possible, to eradicate, this insect, that have been adopted in the past. We wish the nurserymen to understand the seriousness of having this pest gain entrance to their plantations, and that when it does occur, they must bear the burden themselves. There is no provision, to my knowledge, by which any of the nursery tax or other fund may be used to help them out of their difficulties. We cannot do better than call the attention of those who have been ready to criticise the action of the office in this matter, to some extracts of the State law dealing with this question. They are given below:

Extracts from Amended Crop Pest Law, approved May 9, 1903;

"Sec. 2. The Board of Crop Pest Commissioners shall have power to provide quarantine rules and regulations concerning the sale

and transportation of all plants, or parts of plants, commonly known as nursery stock, within the State. They shall also have power to provide like rules and regulations in regard to all plants or parts of plants commonly known as nursery stock, entering this State from without, and these rules and regulations shall be enforced by the State Entomologist or his duly authorized assistants.

"Sec. 4. The State Entomologist, or any of his assistants, or a local inspector as hereinafter provided for, shall have power under the rules and regulations of said board to determine the nature and method of the treatment to which any infested plants shall be subjected, and he shall report his findings in print or writing, giving reasons therefor, to the owner of the infested plants, his agents or tenants, and a copy of such report shall be submitted to said board, and there shall accompany each and every such report specific directions as to the treatment of the infested plants, which directions may be in print or in writing. In case of objection to the findings of the State Entomologist or an assistant, or local inspector, an appeal shall lie to the said board, whose decision shall be final; such appeal must be taken within seven days from the receipt of the report, and shall act as a stay of proceedings until it is heard and decided.

"Sec. 11. It shall be the duty of the State Entomologist, either in person or by an assistant or local inspector, to supervise and direct the execution of any recommendations, made under the provisions of section two of this act, and all expenses of treatment, control and eradication of any infested trees or plants shall be borne by the owner of the premises upon which the same are located, as provided for in sections four and five of this act."

Extracts from the rules and regulations adopted by the Board:

"5. INFESTED NURSERY PREMISES—HOW DEALT WITH—Any nursery premises within this State, which shall upon inspection prove to be infested with any one or more of the insect pests or plant diseases specified in Section 2, shall not be entitled to a certificate of freedom from disease and insect pests until they shall have satisfactorily carried out the directions of the State Entomologist, or an assistant, acting under orders of this board.

"8. THE INSPECTION AND CERTIFICATION OF NURSERIES—It shall be the duty of the State Entomologist, or an assistant appointed by this Board, to inspect all nursery premises in this State at least once each year, and issue to each a certificate in proper form if found entitled to

the same. On the discovery of any infested nursery, the State Entomologist shall pursue such methods as are necessary to eradicate the injurious insects and plant diseases specified in Section 2, of these rules and regulations, and when accomplished a certificate shall be issued in due form."

RECOMMENDATIONS FOR GROWING NURSERY STOCK FREE FROM SAN JOSE SCALE.

First. Before attempting to grow nursery stock, nurserymen should find a locality as free from San Jose scale as possible. No infested orchards should be nearer than a few miles to the nursery.

Second. All propagating wood used should be fumigated. Wood used for apple grafts is cut in the winter, when the San Jose scale is in the dormant state, hence not so readily acted upon by poisons. At this time 50 per cent. should be added to the charge, which will then be 1 1-2 ounces to each 100 cubic feet of air space in the fumigating room.

Third. During the winter after the first year's growth stock should be treated twice with the lime-sulphur wash. This should be done so thoroughly as not to leave a spot untouched by the wash.

Fourth. The stock should be cultivated carefully so as to be ready for sale at the close of the second year. Stock not disposed of at that age, should either be destroyed or cut back to whips and treated as in three, above.

LIST OF NURSERIES NOW IN OPERATION IN THE STATE.

COUNTY	POSTOFFICE	PROPRIETOR
Albemarle. . . .	Greenwood . . .	Thos. Semmes, Bonavista Nurseries.
Albemarle. . . .	Red Hill	J. O. Barksdale.
Albemarle. . . .	Charlottesville .	B. E. Wheeler, Oakland Nurseries.
Amherst	Clifford	C. J. Tomes.
Augusta	Knightly.	N. L. Shreckhise.
Augusta	Staunton	J. H. Lupton, Staunton Nursery.
Augusta.	Stuarts Draft . .	W. B. Dodge.
Augusta.	Waynesboro. . .	G. A. Coyner, Central Point Nurseries.
Bedford.	Bedford City . .	A. S. Johnson, Peaks of Otter Nurseries.
Bedford.	Fontella.	Geo. E. Murrell, Orchard & Nursery Co
Campbell	Lynchburg No. 1.	John Williams & Sons, Campbell County Nurseries.
Carroll.	Woodlawn. . . .	E. W. Jones, Woodlawn and Southwest Va. Nurseries.
Charlotte	Charlotte C. H .	G. W. Davis.
Chesterfield. . .	Midlothian . . .	J. B. Watkins & Bro., Elmwood Nurseries
Fairfax	Falls Church . .	D. O. Munson, Munson Hill Nurseries.
Fairfax	Swetnam	E. H. Jones.
Fauquier	Opal	T. M. Hanback.
Floyd	Hemlock.	Martin & Wickham.
Frederick. . . .	Chambersville. .	N. J. Wigginton, Chambersvilie Nurseries and Orchards.
Frederick	Winchester . . .	D. B. Kater.
Frederick	Winchester . . .	R. A. Wickersham, Shenandoah Valley Nurseries.
Grayson.	Saddle.	C. M. Phipps, New River Nurseries.
Greenesville. . .	Emporia.	C. S. Lindley, Emporia Nurseries.
Henrico	Richmond. . . .	W. E. Cutshaw, City Nurseries.
Henrico	Richmond. . . .	W. T. Hood & Co , Old Dominion Nurseries.
Lee	Rosehill.	C. C. Davis, Silver Leaf Nurseries.
Loudoun. . .	Purcellville .	A. B. Davis & Son, Inc.
Madison.	Radiant.	Louis Oddenino.
Nelson.	Avon	Blue Ridge Nursery Co.
Nottoway	Crewe.	C. E. Wilson.
Nottoway	Nottaway	W. L. Epes.
Page.	Kimball. . .	A. Bolen, Page Valley Nurseries.
Patrick	Ararat.	John A. Young.
Prince William .	Manassas	F. A. Cockrell Graham Park Nurseries.
Prince William .	Manassas	T. A. Metz, Bull Run Nurseries.
Pulaski	Draper	Jos. Draper, Climax Nursery Co.
Roanoke.	Salem.	J. G. Wertz, Wertz Nurseries.
Rockbridge . . .	Fairfield and Buena Vista	S. M. Huffman.
Rockingham. . .	Dayton	C. D. Wenger, Wenger's Nurseries.
Rockingham. . .	Grottoes.	J. N. Baber, Grottoes Nurseries.
Scott	Hartshill	Larkey & Hart, Enterprise Nursery Co.
Scott	Nickelsville . . .	B. M. Francisco.
Washington . . .	Bristol.	Globe Nurseries.

NURSERY STOCK FROM OTHER STATES.

The reader is referred to the Fourth Report for outline of the policy of this office in accepting certificates of nursery inspection from other States, and inspection of imported nursery stock. Of course, it is impossible, under present conditions, to inspect all nursery stock brought into the State. We have, however, this season paid much closer attention than formerly, to this part of the work. We were enabled to do so because a number of local inspectors are now employed in the different counties of the State, and much of the work can be done by them.

Fig. 1—Diseased Apple Tree Roots.

Notwithstanding the fact that we have sent out copies of the Virginia law and circulars giving descriptions of the different insects and diseases proscribed by the law, some nurserymen persist in shipping stock that is diseased with crown gall. Some stock has been found this season that was quite badly affected by this disease. (See Fig. 1, reproduced from a photograph of roots found in shipment of stock this season.) At *a* it will be seen that the main root did not develop, and that the root system appears to radiate from a knot at its base. The orchardist does not care whether or not this is a true case of crown gall. It is enough to know that the tree has a deficient root system which cannot take firm hold upon the soil and produce a good tree. All of these trees were two years old, but the one at *b* is the only one that approaches the size a well grown tree should have at this age. This tree shows a typical gall with fibrous roots. The one at *c* shows mainly the fibrous roots, but it has the enlargement peculiar to this disease also. A healthy apple tree root is shown in Fig. 2.

As mentioned in former reports, apple trees diseased with crown gall, or badly affected with woolly aphis, when planted in the orchard, cannot be relied upon to produce strong, healthy trees. While they may grow about as well during the first few years, they do not take firm hold in the soil, and usually begin to fail and die at the age of 10 to 12 years, just about the time they should come into profitable bearing.

We are very glad to state, however that the character of the nursery stock now being shipped into the State, is much better than it was a few years ago. Certificates of nurserymen found to be shipping diseased stock are revoked as required by law. (See Section 12.)

Fig. 2—Healthy Apple Tree Root.

Consider the following as an average estimate per acre for planting and maintenance of apple orchards:

1 Acre of land	$25 00
50 Trees, at 10c.	5 00
10 Years' care, including planting, at $7.50	75 00
Total	$105 00

If diseased nursery stock is used the orchard may become entirely worthless at the end of the tenth year, and the only thing that can be shown for the outlay of $105.00 is the value of the land. Considering the matter in this light it will be a good business proposition to start with healthy trees even if they cost many times the amount indicated above.

EXPENSES.

The actual cost of nursery inspection, and the inspection of nursery stock imported from other States, has been paid almost entirely from the funds raised by the nursery tax.

Present conditions indicate, however, that a much larger amount will be required to cover the expenses of nursery inspection and supervision during the next few years.

RELATIVE QUANTITY OF NURSERY STOCK GROWN IN THE STATE DURING THE PAST FEW YEARS.

The number of nurseries in operation in the State this year is somewhat larger than that of last year. A few names have been added to the list, while others were dropped, as the parties ceased to do nursery business. Our present list shows 44 nurseries scattered over entire State, as given in the above list. Practically all of these nurseries have been visited several times during the season.

The quantity of nursery stock grown in the nurseries of the State in 1903 was 30 to 40 per cent. greater than that grown in 1902, though the number of nurseries in operation was somewhat smaller. The quantity of stock grown in 1904 and 1905, however, was about the same as that grown in 1903. Nurserymen buy nearly all of the seedlings used in propagating apple trees from the West. The heavy rains of 1903 destroyed quite a number of seedlings in that section, and, as a result, prices in the spring of 1904 were from three to four times as high as usual, causing some nurserymen to plant much less stock than they had anticipated. As apple trees are grown two to three years in the nursery, this operated to reduce quite largely the amount of nursery stock that would have been grown during the past two years. Yet under these difficulties, the amount of stock grown was about as large as that grown in

ORCHARD INSPECTION.

A list of the 72 counties in which some orchards known in 1903 to be infested with San Jose scale, are located, was given in the Fourth Report. Since that date, infested orchards have been located in 6 other counties, making a total of 78 counties in which this insect is known to occur. The names of the counties added to the list during the past two years are given below:

Alleghany, Carroll, Charlotte, Highland, Norfolk, Nottoway.

Only a very few cases of San Jose scale have been located in these counties, yet this may largely be due to the fact that little time has been

spent on the inspection work in these counties. There are some counties, however, that have been well inspected, but only a few infested orchards discovered.

The means at our command are not sufficient to enable us to inspect all the orchards, but the law has a provision under which the different counties may take up this work and enforce the treatment of infested orchards. It is left with the fruit growers to take the initiative in this matter, but this office is ready to help in every way possible to forward the work. Sections 9 and 10 of the law, which relate specially to the county inspection work, are given below.

**Extracts from Amended Crop Pest Law, approved May* 9, 1903:

"Sec. 9. Upon a petition signed by ten freeholders of any city, county, or magisterial district, it shall be the duty of the State Entomologist, in person or by an assistant, to make a preliminary investigation of the locality from which the petition is received, to ascertain if any trees or plants be infested with the insect known as the San Jose scale. If, upon such preliminary investigation, it shall appear that the San Jose scale is present in the territory examined, the State Entomologist shall appoint a local inspector, and order a full inspection of such city, county or magisterial district, to discover and locate all infested premises; and the local inspector shall report the results of such further inspection to the owners of all infested premises, and to the board of supervisors of the said county or the city council of said city, giving the location of all said infested trees and plants, and the extent of infestation in each case, and make specific recommendations in accordance with the instructions furnished him by the State Entomologist, which instructions may be printed or written.

"Sec. 10. The board of supervisors of any county or city council of any city in which a local inspector has been appointed shall fix the compensation of such local inspector, whose pay, however, shall not in any case be less than one dollar and fifty cents for each day's work, and said local inspector shall file before the said board of supervisors or city council from time to time an itemized account of the expenses and costs incurred in the performance of his duties, and a statement of the days actually occupied in the performance of the duties hereinbefore prescribed, and the same shall be allowed him and paid as other claims against the county or city, not to exceed two hundred and fifty dollars in any one year. But the board of supervisors of any county or the council of any city may appropriate any sum in excess of two hundred

* For further information and full copy of the law, with rules and regulations adopted under same, see circular 32, of this office.

and fifty dollars which it may deem proper. The sum appropriated in any year in excess of the actual requirements of such year shall not be considered as an appropriation for any subsequent year."

Since the passage of the Amended Crop Pest Law, (May 9, 1903), 36 inspectors have at different times been employed on the local inspection work in the different counties of the State. Only 28, however, are acting at this time. This work has been taken up in 18 counties since that date.

A list of these counties with inspectors employed in them is given below:

Albemarle County.
T. J. Dolen . . . . . Yanceys Mills.
Alleghany County.
E. C. Roller. . . . . Covington.
Amherst County.
Jno. E. Rucker . . . . . Agricola.
Augusta County.
E. L. Houff, Jr. . . . . Fort Defiance.
*M. L. Houff. . . . . New Hope.
W. A. Obaugh . . . . . Mt. Solon No. 1.
David O'Rork. . . . . Staunton.
*G. M. Thacker . . . . . Stuarts Draft.
W. E. Tribbett . . . . . Spottswood.
Bedford County.
R. A. Burks . . . . . Peaksville, No. 1.
*Robt. N. Gaines . . . . . Chamblissburg.
R. C. Noel . . . . . Bedford City No. 6
Campbell County.
*Wm. A. White . . . . . Lynchburg, No. 1.
Carroll County.
E. J. Webb . . . . . Hillsville.
Clarke County.
Chas. R. Castleman. . . . . Berryville No. 2.
Floyd Couuty.
*S. W. Cole. . . . . Flint.
W. H. Poff . . . . . Floyd.
J. A. L. Sutphin . . . . . Topeco.
Frederick County.
W. W. Tanquary . . . . . Winchester.
Greenesville County.
Chas. F. Masterson . . . . . Belfield.
Madison County.
W. F. Crigler . . . . . Madison.
*H. N. Harrison . . . . . Madison.
Montgomery County.
J. T. Harman . . . . . Christiansburg.
Nelson County.
P. C. Hill . . . . . Tyro.
Patrick County.
A. C. Turner. . . . . Buffalo Ridge.
Pulaski County.
J. A. Naff . . . . . Dublin.

Rappahannock County.	
A. M. Wood	Washington.
*F. D. Wood	Washington.
Rockbridge County.	
*G. D. Clemmer	Rockbridge Bath.
G. F. Pultz	Buena Vista No. 2.
C. L. Thompson	Buena Vista No. 2.
Rockingham County.	
J. B. Coffman	Dayton, No. 19.
Shenandoah County.	
H. E. Bailey	Woodstock.
H. C. Rosenberger	Mauertown, No. 1.
Wythe County.	
G. W. Kegley	Crocketts Depot.
W. R. Huffard	Wytheville.
*J. A. Snaveley	Crocketts Depot.

* Resigned.

Since the Tidewater and Middle Virginia sections of the State, with but few exceptions, grow very little fruit, the local inspection work has been confined almost entirely to the other sections. The Piedmont and Valley sections of the State each have 7 counties in which no local inspectors have been appointed. Appalachia has only one county in which a local inspector is at work.

A number of the counties given in the above list have been quite thoroughly inspected and a large number of orchards treated carefully for the San Jose scale. This work has been, in the main, successful, and the orchardists appear to be holding this pest in check. The most notable results, however, have been obtained in a few counties where the San Jose scale has not yet become generally disseminated. If a concerted effort is made to have the law enforced, it is likely that the pest can be kept out of the important orchards for many years. We wish to call special attention to this matter, and urge fruit growers to unite and aid as far as possible in the suppression of this insect.

An inspector has been employed 51 days in Carroll county. In this time he inspected 331 orchards, but only one case of San Jose scale has been discovered. This is a very fortunate state of affairs, and the same would likely be true in a number of other counties where fruit growing has begun its special development in very recent years. This should not, however, make the fruit growers feel assured, for it is the very time to put forth an effort to control this insect and to prevent it from gaining entrance to the orchards.

We think no one familiar with the ravages of the San Jose scale will contradict the statement that an orchard infested with it must be carefully treated in order to grow good fruit, and even to preserve the life of the trees. And while materials now recommended are quite effective, the operation is expensive.

It would cost about 5 cents per tree to treat an orchard ten years old. Hence the cost of treating a family orchard of 250 trees will be $12.50. If there are 200 such orchards in the county, by keeping

this insect from them, a saving of $2,500.00 is effected annually. This is a very small estimate. In some of the counties where fruit growing is an important industry, 4 to 5 of the fruit growers would together have this number of trees, and these few persons would have to bear an expense for treatment equal to the above. Considering the matter in this light, there is no more important work than that of preventing the spread of the San Jose scale.

FUMIGATION OF NURSERY STOCK WITH HYDROCYANIC ACID GAS—A BRIEF STUDY.

While the fumigation of deciduous nursery trees in the dormant season has come to be conceded the most effective and economical method for ridding them of San Jose scale, woolly aphis and other insects of like nature; and this process has now come into general use throughout the United States, it must also be conceded that this operation is one in which we must observe proper precautions or failure to rid the plants of these pests will result. Indeed, there are so many conditions to be taken into account in doing this work that the writer regards a certificate of fumigation as of little value unless the operator is known to be painstaking, and also has considerable knowledge of the changes that take place in the fumigating room. There are, however, a number of cases on record where living San Jose scale have passed through the fumigating process even when the operators were known to be painstaking and careful. Because of these facts and the great importance of having nursery trees free from San Jose scale when they are planted in the orchard, some investigations were begun in the spring of 1904, to find, if possible, the cause of failure, and also to learn whether the formula now recommended for this work could be relied upon to kill the San Jose scale and not injure the plants. While the investigations are by no means complete, inspectors generally appear to have overlooked a number of the points observed by us, which are regarded as of sufficient importance for presentation at this time.

PURITY OF POTASSIUM CYANIDE.

The first inquiry was as to the degree of purity of the various brands of potassium cyanide available for use by Virginia nurserymen. The analyses made at the beginning showed that very inferior grades of potassium cyanide were being used, many samples being adulterated to such an extent that they did not contain more than 50 per cent. potassium cyanide. This was deemed of so much importance that the following circular was issued and sent to our nurserymen on June 30, 1904, so as to be in their hands for the fall shipments of that year. This circular is printed in full below:

"The practice of fumigating nursery stock with hydrocyanic acid gas for the purpose of destroying injurious insects, especially the San

Jose scale insect, which has become more and more generally distributed throughout the nurseries of the country has now become one of the very essential operations of the nursery. Consequently the question of efficient fumigation becomes one of the utmost importance. As the efficiency of this work depends, primarily, upon the purity of the potassium cyanide used, and as it is well known that there are various grades of potassium cyanide sold in the market, it has seemed proper for us to undertake an investigation of this article, from samples found in common use, for the purpose of giving more definite information to the nurserymen in regard to its purity, hoping thereby to establish the work of fumigation upon such a firm basis as to make it practically impossible for any insects to persist alive upon stock which has been passed through the fumigation houses.

"We have always recommended the use of potassium cyanide of 98 per cent. purity for fumigating purposes and have repeatedly urged Virginia nurserymen to use no other grade of cyanide and to require a proper guarantee as to purity, but many users of this chemical purchase quite indiscriminately from local dealers, without paying strict attention to these recommendations, and even if they may mention the matter of the guarantee as to purity, to the local dealer, it is generally true that he does not himself know whether the stock he is selling contains 98 per cent. or 50 per cent. potassium cyanide.

"This matter has become of such importance that we have undertaken to determine the strength of various samples of potassium cyanide which are now being used by Virginia nurserymen. Acting upon this idea we collected nine samples from stock in the hands of State nurnurserymen, six of which were purchased through dealers and three from manufacturing chemists, who make it a business to handle potassium cyanide of known grades of purity, in large quantities. All the samples collected from cyanide obtained through dealers, were found to be quite impure, some of them showing on analysis, less than one-half of the strength which we have required, and none of them showing much over half the strength necessary for safe work. On the other hand, the three samples collected from cyanide obtained direct from manufacturing chemists show on analysis, from 95 to 99 per cent. purity, which on the whole renders them reliable for fumigation work.

See tabular statement below for purity of the various samples:

Data on the Analyses of Samples of Potassium Cyanide.

Sample No.	Taken from Cyanide Purchased of a	Guaranteed Purity.	Found to be.
1	Manufacturer in Baltimore	98%	95%
2	Richmond dealer		47%
3	Manufacturer in New York	98%	99%
4	St. Louis dealer		55%
5	Baltimore dealer	98%	52%
6	Local dealer		49%
7	Manufacturer in New York	98%	99%
8	Local dealer		47%
9	Greensboro dealer		†

† The appearance of this sample indicated it to be of poor quality, but as it had been damaged it was not analized.

"These analyses render it very clear that ordinarily one cannot depend upon the purity of potassium cyanide purchased from dealers, unless it comes in unbroken packages with the guarantee of a reliable manufacturing chemist on the package. This statement does not in any wise impeach the conduct of dealers, but it is intended to emphasize the necessity upon the part of nurrserymen of purchasing only known grades of cyanide. It has become absolutely necessary for this office to insist upon the use of standard grades of potassium cyanide, otherwise the fumigation work which we are requiring in the nurseries for the protection of purchasers of nursery stock, will prove a deception rather than a safeguard to the people.

"The lower grades of potassium cyanide cannot be relied upon for fumigation work. They vary so widely in strength that no formula can be given to guide one in using them. The writer recently obtained quotations on cyanide of 98 per cent. purity from several reliable chemists, and found the prices to vary from 25 cents to 35 cents per pound, depending upon the quantity purchased, while local dealers charge from 35 cents to 40 cents per pound for the poorer grade goods. Thus you will see that the high grade article is also less costly if purchased direct from the manufacturer.

"We urge Virginia nurserymen when purchasing potassium cyanide to demand that it be delivered in unbroken packages which carry a reliable guarantee that the contents is 98 per cent. pure potassium cyanide. This office expects to pay special attention to this matter in the future and will have other samples of cyanide analyzed from time to time.

"The following formula was agreed upon at a recent meeting of leading entomologists as being the best for fumigating nursery stock:

Fused potasium cyanide 98 per cent.	1 ounce	To each 100 cubic feet of space in the fumigating room.
Commercial sulphuric acid (high grade)	2 fluid ounces	
Water	4 fluid ounces	

"This formula differs slightly from the one formerly recommended by this office, but the amount of potassium cyanide is the same and the cyanide governs the strength of the gas, provided the acid and water are present in sufficient quantity. In view of these facts we have decided to recommend the formula given above for general use by Virginia nurserymen."

The above analyses as well as those given in a later table were made by James H. Gibboney, Assistant Chemist at the Virginia Polytechnic Institute. In almost every case two careful analyses were made by the volumetric method, and the average of the two given as the final result. Quite a number of samples were analyzed after the above circular was issued, and some of the results are given in the following table:

Data on the Analysis of Samples of Potassium Cyanide.

Sample No.	Obtained From	Guaranteed Purity.	Found by Analysis to Contain.
10	Dealer in Baltimore, Md		44%
11	" " "		99%
13	" " "	98%	99%
14	Manufacturer in New York	98%	97%
16	" " "	98%	98%
17	" " "		98%
17½	" " "		98%
18	Dealer in Lynchburg	98%	88%
19	Dealer in Philadelphia		52%
20	Nurseryman		57%
21	"		59%
22	Dealer in Lynchburg	98%	97%
26	Nurseryman		96%
27	Manufacturer in New York		95%
28	" " "		98%
29	Dealer in Richmond	98%	98%
33	" "	98%	55%
34	" "	98%	98%
35	Dealer in Philadelphia	98%	98%
36	Dealer in Baltimore	98%	98%

From this table it will be seen that all samples furnished directly by the manufacturer were good grade, though a few of them fell a little below the 98 per cent. standard. The chemist tells me the samples that analyzed as high as 96 per cent. were not adulterated, but that the others were adulterated, the chief adulterants being common salt (sodium chloride), and chloride of lime. According to Wilmon Newell (see bulletin 15, of the Georgia State Board of Entomology) if chlorides are present, they cause a portion of the hydrocyanic acid to break down or decompose, and a smaller amount of gas is made available than indicated by the per cent. of potassium cyanide in the sample. This being the case, it is no easy matter to tell just how much of the poor grades will be equal to a certain given quantity of the pure cyanide, and the high grade cyanide should always be used for fumigating purposes.

Some samples of potassium cyanide are adulterated to such an extent that one can tell it to be of poor quality at a glance, though the appear-

ance cannnot be relied upon like a chemical analysis. The good grade is highly crystalline, almost pure white, and breaks up into lumps of the same external appearance on all sides. But the poorer grades have usually the appearance of being cast in a mould, this appearance showing on most of the lumps. The lumps are very hard and present a more smooth surface than the high grade article. It is often somewhat dark in color, but is usually very much like plaster of Paris that has been wet and allowed to dry. Moisture often collects on the outside of these lumps and may be present in large drops.

The safe method is to buy only sealed packages that bear on the outside the guarantee of a reliable manufacturer that the contents are of 98 per cent. purity, and even then, if it does not present the crystalline appearance mentioned above, it should not be used. It should be kept in air-tight vessels to prevent it from taking up moisture from the air and consequent deterioration.

TEMPERATURE AS IT AFFECTS FUMIGATION METHODS.

Nursery stock is not often fumigated when the temperatutre is below 35° Fahrenheit. Neither is the temperature likely to be higher than 75° to 80° except when fumigating bud wood during the summer. This being the case, the temperature would have very little, if any effect on the final results. During the season of 1904, however, careful data were taken on the temperature both inside and outside the fumigating room. At least 20 charges were placed, in which the amount of chemicals varied from 2-3 to 6 2-3 ounce for 100 cubic feet of air space. The temperature on the inside of the house remained almost the same as that on the outside. The variation was not more than 1 to 3 degrees.

Hydrocyanic acid passes off as gas at 80° Fahrenheit. Hence, if the fumigation is to be successful, the temperature of the liquid should remain above 80° until practically the entire amount of gas is given off. The average temperature of well and spring water is about 50° to 70° Fahrenheit, but when concentrated sulphuric acid is added, at the rate of 1 part to 2 parts of water, it raises the temperature about 150°, or far above the temperature required for this acid to be given off as a gas. This will be the case even if the temperature of the water is near the freezing point.

If a weaker acid is used, even though a much larger quantity, the same temperature will not be obtained, hence, it is necessary to use the concentrated acid for fumigating purposes. The cyanide must be added within a few minutes after the acid, so that it can be acted upon before the temperature falls too low.

Outside conditions have very much more influence on a small quantity of liquid than on a larger body; hence, for fumigating even small quantity of bud and graft wood, a house should be used that is large enough to require at least 1 ounce of potassium cyanide for each charge.

DIFFUSION OF HYDROCYANIC ACID GAS—RESULTS OF FUMIGATING SAN JOSE SCALE IN A HOUSE TIGHTLY PACKED WITH NURSERY STOCK.

The proper distribution of gas in the fumigating house is of so much importance that an attempt was made in the fall of 1904, to study the killing effect upon the San Jose scale in the far corners of a large fumigating room where the gas was generated at one point only. A house 23 1-2 x 9 1-4 x 7 1-3 feet, with an arrangement at one side for admitting the chemicals, was secured for these experiments. The entire charge was placed in one jar through this opening at the side of the house. The distance from the jar to one of the far corners of the room was about 13 1-2 feet, and to the other corner about 16 feet.

The infested apple trees, 22 in number, were arranged in 8 different lots, 1 of which was used as a check. Of these infested trees, 2 lots, Nos. 601 and 602, were fumigated October 24, 1904, each lot being placed in one of the far corners of the room, about 13 1-2 and 16 feet, respectively, from the fumigating jar. The house was then packed very tightly with nursery stock, but no more tightly than the writer has often observed to be the case in ordinary nursery work, where it is not done under proper supervision. The charge, 1 ounce of potassium cyanide, 2 ounces sulphuric acid and 4 ounces of water, to each 100 cubic feet of air space, in the room, was then placed, and the room left closed 40 minutes. The cyanide used, proved, upon chemical analysis, to be 98 per cent. purity, and the acid tested 1.83 specific gravity. The other lots were fumigated later in the same manner. The following table gives the data in detail:

Data on Fumigation of Trees Infested with San Jose Scale, in House Tightly Packed with Nursery Stock.

Test No.	No of Trees in Test.	Degree of Infestation of Trees.	Date of Fumigation.	Amount of Potassium Cyanide used to each 100 cu. ft. of air space.	Result of Examination, August 1, 1905.
601	2	1 About half coated . . . . 1 Slightly infested	Oct. 24, 1904.	1 oz.	1 Mature and 1 young insect on 1 tree.
602	2	Slightly infested . . .	Oct. 24, 1904.	1 oz.	No live insects.
603	2	1 About half coated . . . . 1 Slightly infested	Oct. 25, 1904.	1 oz.	No live insects.
604	2	More than half coated . .	Oct. 25, 1904.	1 oz.	Live insects abundant on both trees.
605	4	1 About half coated . . . . . 3 Slightly infested	Oct. 29, 1904.	1 oz.	Live insects fairly abundant on all trees.
606	4	Slighty infested to about half coated	Oct. 29, 1904.	1 oz.	No live insects.
607	2	1 About half coated . . . . . 1 Slightly infested	Oct. 25, 1904.	1 oz.	Live insects fairly abundant on 1st tree; few on 2nd tree.
608	4	1 About half coated . . . 3 Slightly infested	Not fumigated		Live insects very abundant.

After the stock was fumigated, it was heeled into the soil to pass the winter. It was planted in the field early in the spring. The check plot was planted several hundred feet distant with other stock between, and the workmen in cultivating the trees were not allowed to pass directly from this plot to the other trees. When examined on August 1, 1905, however, there were only three lots on which no living San Jose scale were found. Only a few living San Jose scale were found on one lot, but they were quite abundant on 3 of the other lots.

The lot of unfumigated trees in this experiment was packed in the same box with the fumigated trees on November 10th, and shipped to Blacksburg. The unfumigated lot was, however, carefully covered with straw to keep it from the other trees, and, in view of the fact that the season was very early, the temperature ranging from 17 to 67 degrees during the entire month, the insects were not breeding and the writer is of opinion that the fumigated trees could not have become infested from this lot. In fact, no crawling young could be found on the unfumigated trees when the box was opened in Blacksburg a few days later. Besides, the large number of scale found on the fumigated lots August 1st, precludes the idea of their having spread from the check trees, and indicates clearly that they must have escaped the effects of the gas.

CONCLUSIONS AND GENERAL NOTES.

In the writer's opinion, the above experiment proves conclusively that fumigation will not be effective when the stock is packed tightly in the house. No matter what other precautions are taken, if opportunity is not afforded for the free distribution of the gas from the generator, live San Jose scale may successfully pass through the process of fumigation.

Nurserymen should be very careful in fumigating stock to have it stood up loosely in the house. The jars should be placed so that the gas does not have more than 5 to 6 feet to penetrate to the far corners of the room, and it would be much better if an aisle were left the entire length of a large room, sufficiently wide for one to pass through and place the chemicals.

The usual recommendation for fumigating nursery stock is to place the vessel in which the gas is to be generated as nearly in the center of the fumigating room as possible, and, in case of a house larger than 8 by 10 feet, to use two or more jars and distribute the chemicals accordingly. It is quite likely, however, that nurserymen in the hurry of work incident to the shipping season, do not always follow these instructions, and we have reason to suspect that the fumigating room is often packed quite full of trees, and the generator then placed near the door.

Professor Penny, of Delaware, studied the question of the diffusion of gas, the results of which appear in the report of the Delaware Experiment Station for 1900. He found that, when the generator was placed in one end of room 20 feet long, it required from 30 to 60 minutes for the gas to become evenly distributed. But when the generator was placed in the center of the room, the gas became evenly distributed at the end of 10 minutes.

In each of the cases tested by him, however, the room was empty, and therefore no obstacles placed in the way of circulation of the gas. In a house packed very tightly with nursery stock, it is evident that the circulation will not be nearly so rapid as under the above mentioned conditions. Hence, in this case, if the charge is left in the room only 40 minutes, the gas may not reach the remote corners of the room at all.

Professor Penny's experiments show what would be expected, in that this gas, being lighter than air, (it is warmer also at the time it is generated, and therefore, still lighter), rises rapidly to the ceiling, from which point it scatters to different parts of the room. Stock should be stood up loosely in the fumigating house. The generator should then be placed in the center of the room, if it is not larger than 8 by 10 feet. The diffusion of gas in this case should be almost as rapid as in an empty

room, but, as mentioned above, the distribution of gas cannot be complete in a house where the stock is tightly packed.

A slatted flooring has often been recommended, but, unless it is properly arranged, very little will be gained by it. A slatted floor, to be of service, should be built 12 to 18 inches above the real floor. On the outer edge the slats should be 3 inches wide and placed about one-half inch apart, but they should be placed edge and edge in the center of the room so as to make a space about 5 feet square for distributing the gas. A trap door in the center will allow the chemicals to be let down. As the gas cannot readily pass through the floor in the center of the room, it will be scattered to the edges, and thus to all parts of the room. Yet if the stock is very tightly packed, even this arrangement would not make the distribution of gas anything like perfect.

NURSERY STOCK INFESTED WITH SAN JOSE SCALE, FUMIGATED UNDER VARYING CONDITIONS.

Professor Penny, of Delaware, found that, if any considerable amount of water is present on leaves of plants at the time they are fumigated, as much as 25 per cent. of the gas may be absorbed by this moisture, and thus leave a much smaller amount available for killing the San Jose scale. The gas taken up in this way is brought into closer contact with the trees and makes injury more liable to result. While this appears to be true, and the general recommendation has been to fumigate stock while dry, it was thought advisable to plan this series of experiments to determine whether or not, San Jose scale protected in this way would come through the fumigation alive, and, if this is not true, and the insects are killed by fumigation under these conditions, whether or not it is advisable to adhere to the former recommendation and fumigate stock only when it is dry. The house used for fumigating this stock is 8x9x10 feet. It was built several years ago after the usual plan, and is now in very good condition.

As will be seen from the following table, the trees in series numbered from 201 to 205, inclusive, were in ordinary normal condition when fumigated. The lots numbered from 206 to 210 were sprinkled carefully with water so that the drops could be seen very clearly adhering to the plants, and lots numbered from 211 to 220 were dipped into a puddle of clay. The entire surface of the trees, except the tips of the limbs, was thus covered with mud before they were fumigated. The first of this series were allowed to dry before they were fumigated, while those numbered from 216 to 220 were fumigated while they were still wet with this mud.

The trees were from slightly to moderately infested. That is, the number of San Jose scale present on each tree varied from a few hundred, for slightly infested, to almost half coated in case of the moderately infested trees.

As in the case of all the other experiments conducted at this time, fumigation was continued for 40 minutes. The potassium cyanide used analyzed 98 per cent. purity, and the sulphuric acid tested 1.83 specific gravity. The charge used varied from 2-5 to 1 1-3 ounce of potassium cyanide for each 100 cubic feet of air space in the room. The trees used in all these experiments were Ben. Davis apple, 3 years old and well matured. The number of trees used in each lot was from 4 to 5, 4 being the number most generally used. These data are given in detail in the following table:

Data on Nursery Stock Infested with San Jose Scale, Fumigated Under Varying Conditions.

Test No.	No. Trees in Test.	Degree of Infestation of Trees.	Date of Fumigation.	Condition of Stock.	Amount of Potassium Cyanide used to each 100 cu. ft. of air space.	Result of Examination.	
						August 1, 1905.	October 17, 1905.
201	4	1 Half coated . . . . . 3 Slightly infested	Nov. 16, 1904	Dry.	⅛ ounce.	No live insects.	No live insects.
202	4	Slightly infested	Nov. 16, 1904.	Dry.	⅜ ounce.	8 Live insects.	Live insects abundant.
203	4	Half coated	Nov. 16, 1904.	Dry.	¼ ounce.	No live insects.	8 Live insects on 4th tree.
204	4	Slightly infested	Nov. 17, 1904	Dry.	1 ounce.	1 Live insect on 4th tree .	1 Live insect on 4th tree.
205	4	Slightly infested	Nov. 17, 1904.	Dry.	1⅛ ounce.	No live insects.	1 Live insect.
206	4	Slightly infested to half coated	Nov. 16, 1904.	Wet.	½ ounce.	No live insects.	No live insects.
207	4	Slightly infested	Nov. 16, 1904.	Wet.	⅜ ounce.	No live insects.	No live insects.
208	4	Slightly infested	Nov. 16, 1904.	Wet.	¼ ounce.	No live insects.	No live insects.
209	4	Slightly infested to half coated	Nov. 17, 1904.	Wet.	1 ounce.	1 Young insect on 1st and on 2nd tree.	1 Young insect crawling on 3rd tree.
210	4	Slightly infested to half coated	Nov. 17, 1904.	Wet.	1⅛ ounce.	No live insects.	1 Young insect crawling on 3rd tree.
211	4	2 Slightly infested . . 2 Half coated	Nov. 16, 1904.	Puddled and allowed to dry, then fumigated.	½ ounce.	No live insects.	1 Live insect on 2nd tree.
212	4	Slightly infested	Nov. 16, 1904.	Puddled and allowed to dry, then fumigated.	⅜ ounce.	No live insects.	No live insects.
213	4	Slightly infested to half coated	Nov. 16, 1904.	Puddled and allowed to dry, then fumigated.	¼ ounce.	No live insects.	No live insects.

Data on Nursery Stock Infested with San Jose Scale, Fumigated Under Varying Conditions—Continued.

Test No.	No. Trees in Test.	Degree of Infestation of Trees.	Date of Fumigation.	Condition of Stock.	Amount of Potassium Cyanide used to each 100 cu. ft. of air space	Result of Examination.	
						August 1, 1905.	October 17, 1905.
214	4	Slightly infested to half coated	Nov. 17, 1904.	Puddled and allowed to dry, then fumigated.	1 ounce.	No live insects.	No live insects.
215	4	Slightly infested . . .	Nov. 17, 1904.	Puddled and allowed to dry, then fumigated.	1⅓ ounce.	No live insects.	2 Live insects on 2nd tree.
216	4	Slightly infested	Nov. 16, 1904.	Puddled and fumigated while wet.	½ ounce.	No live insects.	No live insects.
217	4	Slightly infested to half coated	Nov. 16, 1904.	Puddled and fumigatad while wet.	⅔ ounce.	No live insects.	No live insects.
218	4	Half coated..	Nov. 16, 1904.	Puddled and fumigated while wet.	¼ ounce.	No live insects.	No live insects.
219	4	Slightly infested to half coated	Nov. 17, 1904.	Puddled and fumigated while wet.	1 ounce.	No live insects.	2 Live insects.
220	4	Half coated..	Nov. 17, 1904.	Puddled and fumigated while wet.	1⅓ ounce.	No live insects.	No live insects.

NOTE—Trees in Nos. 209, 215 and 219, were in row adjoining the 600 series, on which was considerable scale. Trees in No. 211 stood in same row, about 4 paces from No. 202 (infested), and No. 204 stood in adjoining row.

No injury resulted from the fumigation, even when the strongest charges were used, but the result on the insects is not quite so conclusive. Unforunately the trees fumigated in the 600 series given earlier in this report, were planted adjoining this lot, and, as the scale was quite abundant on several of these trees, it had an opportunity to spread to the trees in this experiment plot. By consulting the above table, however, it will be seen that in only one case, that of test 202 where 1-2 ounce of potassium cyanide was used for each 100 cubic feet of air space, were there enough San Jose scale on August 1st, to indicate positively that they must have passed through the fumigating process alive.

A live scale was found on 1 tree in lot 204, and also on 2 trees in lot 209, both of which, from the conditions, appear to have become infested from other trees near. As only 1 live insect was found on the tree in test 204, and 1 crawling young on each of the 2 trees of 209, the indications are that these insects came from infested trees nearby. For the San Jose scale begins to bring forth young in this latitude about the 24th to 30th of May, and many insects should have been present at this time, if they had passed through the process of fumigation alive. Yet it is possible that one insect came through this process so weakened as not to develop normally, and it may also be possible that the old female insect was overlooked, though a very careful examination was made.

The result of examination made October 17th, shows that a number of the trees had a few live San Jose scale on them at that time. These data are given without further discussion. A number of these experiments will be repeated this fall, and we hope to present more conclusive data next season.

The indications are that in our experiments no living San Jose scale passed through the fumigating process alive, where the stock was wet or where it had been puddled. Yet, as it has been shown that much gas is absorbed by moisture, it is not considered advisable to fumigate stock when it is wet or covered with earth. Neither is it desirable to use less than 1 ounce of potassium cyanide to each 100 cubic feet of air space.

Nursery stock fumigated with poor grade cyanide.—During the spring of 1904, 2,200 apple trees were obtained from a nursery and planted in an orchard near Linden, Va. This stock was fumigated 40 minutes by using 1 ounce of potassium cyanide of 95 per cent. purity to each 100 cubic feet of air space in the fumigating room. A few of these trees were found to be infested with San Jose scale at the time they were planted, which, of course, indicates that more or less of the trees were slightly infested.

Careful examination of this stock in November, 1905, after it had grown two seasons in the field failed to reveal the presence of a single living San Jose scale.

The same spring 1,100 peach trees and 200 apple trees from an infested nursery were carefully sorted and fumigated with cyanide of 55 per cent. purity. It was not known at the time that this cyanide was below the required strength, yet the trees were fumigated twice, and the first time were left in the fumigating house over night.

While these trees were carefully sorted, and all infested ones were thrown out, some few slightly infested trees must surely have passed into the lot. Examination in November, 1905, after the trees had grown two years in the field, revealed the fact that one peach tree was slightly infested with San Jose scale. In this case, where the stock was fumigated the entire night and re-fumigated a few days afterward, not all the San Jose scale were killed.

This would indicate that adulterated potassium cyanide cannot be depended on to kill the San Jose scale, even under the most advantageous circumstances. Yet we would infer from these results that, had the cyanide been of good grade, the trees would have been freed from this insect.

EFFECT OF FUMIGATION ON THE EGGS OF THE SCURFY SCALE.—(C. FURFURUS).

This experiment was designed to test the effect of hydrocyanic acid gas on the eggs of the scurfy scale. While insect eggs that are sufficiently hardy to stand winter conditions in the open air, are not likely to be affected by fumigation, we often have inquiries as to its effectiveness against the eggs of the scurfy scale, which is quite plentiful in some sections of Southwest Virginia.

In the fall of 1904 the writer secured from a nursery some three year winesap apple trees, which were, in many cases, half coated with the scurfy scale, and fumigated them the following spring. They were dug in the fall and heeled into the soil to pass the winter. They were a little under size, being about the size for two year trees.

The original plan was to fumigate some of the trees in the fall, and compare the results with spring fumigation, but, because of press of other duties, the fall fumigation was abandoned.

The potassium cyanide used was of 98 per cent. purity, obtained from Adler Color & Chemical Works, and the sulphuric acid tested 1.8 specific gravity. The fumigating house described in the preceding section was used for this work. Each lot of stock was fumigated 40 min

utes, but the charges of potassium cyanide used varied from 1-2 ounce to 2 ounces for each 100 cubic feet of air space. These data are given in condensed form in the following table:

Effect of Fumigation on the Eggs of the Scurfy Scale.

Test No.	No. of Trees in Test.	Degree of Infestation of Trees.	Date of Fumigation.	Amount of Potassium Cyanide used to each 100 cu. ft. of air space.	Result of Examination October 17, 1905.
301	4	About half coated.	Mch. 16, 1905.	½ oz.	Mature insects and eggs very abundant.
302	4	About half coated.	Mch. 16, 1905.	⅔ oz.	Mature insects and eggs very abundant.
302a	4	Slightly infested	Not fumigated	Check	Few mature insects.
303	4	Slightly infested to half coated	Mch. 16, 1905.	¾ oz.	Few mature insects.
304	4	About half coated	Mch. 16, 1905.	1 oz.	Mature insects and eggs very abundant.
304a	4	Very slightly infested . .	Not fumigated	Check	Few mature insects.
305	4	Slightly infested	Mch. 16, 1905.	1⅓ oz.	Few mature insects.
305a	4	Slightly infested . . .	Not fumigated	Check	Mature insects and eggs very abundant.
306	4	Slightly infested	Mch. 16, 1905.	2 oz.	Few mature insects.

The trees were inspected from time to time during the summer, but the result given for October 17th is all that need be taken into account, as that is about the average.

About as many eggs hatched on the trees fumigated with the ordinary strength of gas (1 ounce to 100 cubic feet of air space), and weaker charges as on unfumigated trees. Hence, we conclude that fumigation at the ordinary strength of gas has very little value against eggs of the scurfy scale.

Fumigation with a strength of 2 ounces to 100 cubic feet and 1 1-3 ounces to 100 cubic feet may have destroyed the vitality of a few of the eggs, but certainly not enough to make it effective against this insect.

EFFECT OF FUMIGATION UPON NURSERY STOCK UNDER VARYING CONDITIONS.

These experiments were planned to study the effect of fumigation upon nursery stock under normal conditions; also when the stock is

wet or presents broken or cut surfaces to the action of the gas. Trees with the roots cut as practiced in this work are shown in Fig. 3. The size and character of the trees fumigated at this time are shown in Fig. 4. All the stock used in these experiments was in good condition, but, as the work was begun on the 19th of October, some of it was quite green. In fact, many of the twigs, especially of the apple, were broken at the tips while stripping the leaves from them. The stock was dug and heeled in on the shady side of a packing shed to prevent wilting. It was then fumigated either the following day, or in some instances, 2 days later. A very few trees were held over until the third day.

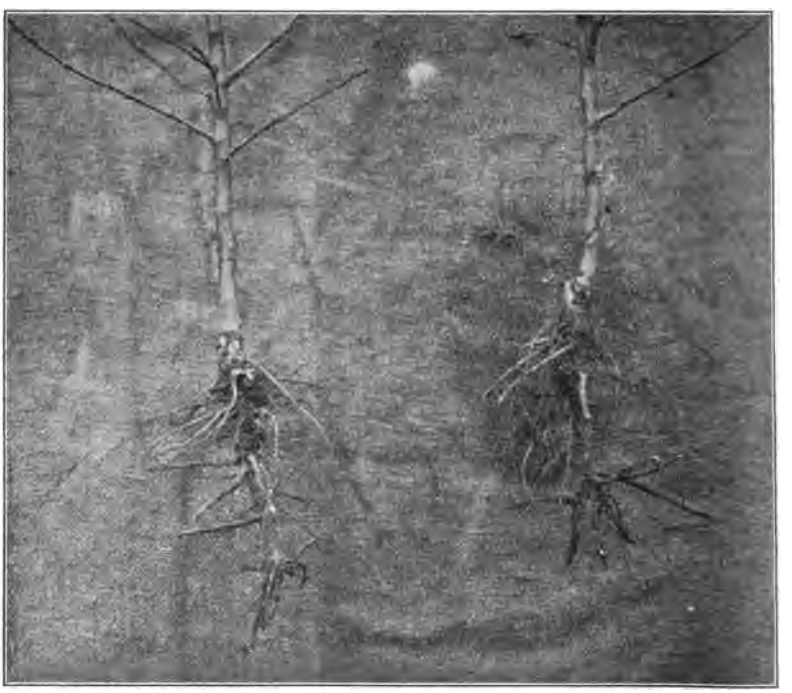


Fig. 3—Apple Trees with Roots Cut.

All the stock was fumigated at the nursery as mentioned above, very soon after it was dug. It was then shipped to Blacksburg on the 10th of November, and planted the following spring for further observation. When the stock was heeled in at Blacksburg, the writer was unable to give this work his personal attention, and when taken up in the spring it was found that it had been heeled into stiff clay soil without sufficient care, and it had not passed the winter in the best condition. This was very unfortunate, and made it difficult to determine the results with the accuracy that could be desired. The fumigated trees came out in almost exactly the same condition as the checks (unfumi-

gated trees), and we feel sure that the conclusions drawn from this work can be relied upon.

Well-grown, healthy stock, like that used in the experiments is, in the opinion of the writer, more liable to injury by fumigation or changes in atmospheric conditions than stock that has grown much more slowly.

All stock mentioned in the tables as being wet was sprinkled with water until the drops stood out quite plainly upon the surface. The

a *b* *c*

Fig. 4—*a* 1 year Peach. *b* 1 year Budded Apple. *c* 2 year Grafted Apple.

roots and tips of the trees were cut back to some extent, in all cases, at time of planting. Hence, if there had been only slight injury to the tips of either the roots or branches, the trees would grow as well as others that had not been fumigated. As this is the proper method of procedure in transplanting trees, however, we do not consider that it need be taken into consideration in this work.

The fumigating house used in these experiments is 4x5x7 1-2 feet, and contains 150 cubic feet of air space. This house was weather-

boarded on the outside, and then ceiled with matched boards. Heavy building paper was put over this ceiling, after which another course of matched boards was nailed over the paper, making the house perfectly tight. The chemicals used were obtained from Eimer & Amend, New York City. Analysis proved the cyanide to be of 98 per cent. purity, and the sulphuric acid tested 1.84 specific gravity. The relative proportions of the 1-2-4 formula, (1 ounce of 98 per cent. potassium cyanide, 2 fluid ounces of sulphuric acid, and 4 fluid ounces of water to each 100 cubic feet of air space), adopted by the Association of Horticultural Inspectors was followed throughout these experiments. Hence, it is thought necessary to give only the amount of potassium cyanide in the tables. The quantity of acid and water can easily be calculated from this.

Unless otherwise stated, the time of fumigation was 40 minutes. As mentioned in another section of this report, however, this is not thought by the writer to be sufficient time for the gas to penetrate to all portions of a large fumigating room. In this case it is considered sufficient.

EFFECT OF FUMIGATION ON BUDDED APPLE STOCK OF ONE YEAR'S GROWTH.

Budded apple trees of the variety known as Starke, of one year's growth, were used mainly in these experiments. This stock was well grown, as indicated at *b*, Fig 4, and measured almost uniformly 5-8 inch caliper. It averaged from 4 to 5 1-2 feet in height. Many of the tips of the limbs were so tender that they were broken in stripping off the leaves. There was, in some cases, also a soft secondary growth at the tips of the twigs that was nearly as tender as the leaves themselves. As the stock was very green at this time, it was thought best to repeat the experiments about the 1st to 10th of November, but so little injury was apparent after fumigation that this portion of the work was abandoned.

The charge used varied from 2-3 to 4 ounces potassium cyanide for each 100 cubic feet of air space in the room. The data in regard to this work are given in detail in the following table:

Effect of Fumigation on Budded Apple Stock of One Year's Growth

Test No.	No. of Trees in Test.	Date of Fumigation.	Condition of Stock.	Amount of Potassium Cyanide used to each 100 cu. ft. of air space.	Result of Examination.			Season's Growth.
					October 28, 1904.	April 14 1905	Oct. 28, 1905.	
1	5	Oct. 19, 1904	Dry.	1 ounce.	Uninjured.	No injury observed, stock in good condition.	No injury observed ; stock in good condition.	4 ft.
1-a	4	. . . . .	. . . . .	Unfumigated.	. . . . .			4 ft.
2	4	Oct. 19, 1904.	Dry.	½ ounce.	Uninjured.			2½ to 3 ft.
2-a	5	. .	. . . . .	Unfumigated.	. . . . .			2½ to 3 ft.
3	5	Oct. 21, 1904.	Dry.	2 ounces.	* A few tips browned.			2 ft.
3-a	3	. . . . .	. . . . .	Unfumigated.	. . . . .			2 ft
4	4	Oct. 19, 1904.	Dry	4 ounces.	* A few tips browned.			2½ ft.
4-a	4	. .	. . . . .	Unfumigated.	. . . . .			2½ to 3 ft.
5	5	Oct. 19, 1904.	Wet	½ ounces	Uninjured.			3 to 4 ft.
6	4	Oct. 19, 1904	Wet.	1 ounce.	Uninjured.			3 to 4 ft.
7	5	Oct. 21, 1904.	Wet.	2 ounces.	Uninjured.			3 ft.
8	4	Oct. 20, 1904.	Wet.	4 ounces.	Uninjured.			3 to 4 ft.
41	5	Oct. 19, 1904.	Tops dry, roots cut and wet.	1 ounce.	Uninjured.			2 ft.
42	3	Oct. 21, 1904.	Stock dry, roots cut.	2 ounces.	Uninjured.			2½ to 3 ft.
42 a	5	. . . . .	. . . . .	Unfumigated.	. . .			2½ ft.
43	4	Oct. 20, 1904.	Stock dry, roots cut.	4 ounces.	Uninjured.			3 ft.
43-a	4	. . . . .	. . . . .	Unfumigated.	. . . . .			3 ft.
52	5	Oct. 22. 1904.	Stock wet.	2 ounces.	Uninjured.			3 to 4 ft.
52-a	5	. . . . .	. . . . .	Unfumigated.	. . . . .			3 to 4 ft.

* A secondary growth occured on these trees after the regular growth had ceased. This portion was much more tender than the regular growth and was the only point at which injury was noted.

No injury was apparent for the first few days after the stock was fumigated except in Nos. 3, 3*a*, 4, and 4*a*. In these cases, the trees had started up a tender secondary growth on a few of the limbs after the main growth had ceased. The checks were in identically the same condition, however, as the fumigated trees, and the injury must, therefore, be charged to the tips being green, rather than to the fumigation. No further injury was observed in the spring when this stock was planted in the field, and both checks and fumigated trees grew splendidly during the summer as indicated in the table.

These results indicate that well-matured apple stock will stand a strength of gas at least two or three times that ordinarily recommended. Nurserymen should, however, not overlook the fact that by packing stock very tightly in the fumigating house, they interfere with the circulation of the gas, and it may be much stronger around the jar where the gas is generated than in other parts of the house. Those who think that their stock has been injured by fumigation should look well to their methods of work. The fault lies there rather than in the strength of the gas.

Effect of Fumigation on Grafted Apple Stock, Two Years Old.

Test No.	No. of Trees in test.	Variety.	Condition of Stock.	Date of Fumigation.	Amount of Potassium Cyanide used to each 100 cu. ft. of airspace.	Result of Examination.*		Season's Growth.
						October 26, 1904.	October 23, 1905.	
13	5	Nickajack.	Dry.	Oct. 19, 1904.	1 ounce.	Uninjured.	Only 1 Tree alive.	Very little growth
14	5	Buckingham.	Dry.	Oct. 21, 1904.	2 ounces.	Tips dryer than others.	Fair condition.	1 foot.
15	4	Buckingham.	Dry.	Oct. 20 1904	4 ounces	Uninjured.	Poor condition.	½ foot.
15-a	4	Buckingham.	. . . . .	Check.	Unfumigated	. . . . .	Poor condition.	½ foot.
16	6	Buckingham.	Wet.	Oct. 19, 1904.	1 ounce.	Uninjured.	Poor condition, three Trees dead.	2 to 3 feet.
17	3	Buckingham.	Wet.	Oct. 21, 1904.	2 ounces.	Uninjured.	Poor condition, one Tree dead.	Little growth.
18	4	Buckingham.	Wet.	Oct. 20, 1904.	4 ounces.	Uninjured.	Fair condition.	2 to 3 feet.
26	4	Nickajack.	Wet.	"	4 ounces.	Uninjured.	Good condition.	Very little growth
26-a	5	Buckingham.	. . . . .	Check.	Unfumigated.	. . . . .	Good condition.	Very little growth
23	3	?	Stripped and Roots Cut	Oct. 21, 1904.	2 ounces.	Uninjured.	Fair condition.	Very little growth
21	5	?	Stripped, Roots Cut and Dry.	Oct. 20, 1904.	4 ounces.	Uninjured.	Fair condition.	2 to 3 feet.
24-a	3	Buckingham.	. . . . .	Oct. 20, 1904.	Unfumigated.	. . . . .	Fair condition.	2 to 3 feet.

* Nearly all the trees were winter killed to some extent. The dead wood was cut off August 14, 1905.

This stock was well-grown, grafted apple, two years old, and apparently well matured. It was handled and fumigated in almost exactly the same manner as the one-year apple mentioned above. It had, however, considerably more top and offered more surface to the wind during the winter, which may account for the injury it sustained. The unfumigated trees were in nearly the same condition as the fumigated trees the entire time covered by the experiment.

No injury was observed until spring, and then the condition and appearance of the stock was such as to lead the writer to conclude that the injury was caused by drying out and winter killing rather than by fumigation.

Effect of Fumigation on One Year Peach.

Test No.	No. of Trees in Test.	Date of Fumigation.	Condition of Stock.	Amount of Potassium cyanide used to each 100 cu. ft. of air space.	Condition of Stock.			Season's Growth.
					October 26, 1904.	April 15, 1905.	Aug. 1, 1905.	
27	5	Oct. 19, 1904.	Stripped and Dry.	1 ounce.	Uninjured.	All dead to within ½ ft. of ground.	Good.	3 to 4 ft.
28	5	Oct 21. 1904.	Stripped and Dry.	2 ounces.	Uninjured.	All dead to within 1 ft. of ground.	Good.	3 to 4 ft.
29	4	Oct. 20, 1904.	Stripped and Dry.	4 ounces.	Uninjured.	All dead to within 1½ ft of ground.	Good.	3 to 4 ft.
37	5	Oct. 21. 1904.	Stripped and Dry.	2 ounces.	Uninjured.	Uninjured.	Good.	3 to 4 ft.
38	3	Oct. 20, 1904.	Stripped and Dry.	4 ounces	Uninjured.	A few dead twigs cut off.	Good.	2 to 2½ ft.
29-a	3	Check.	. . . . .	Unfumigated	Same as Fumig'd Stock.	All dead to within ½ ft. of ground.	Good.	3 to 4 ft.
37-a	4	Check.	. . . . .	Unfumigated.	Same as Fumig'd Stock.	Twigs killed.	Good.	2 to 2½ ft.
31	5	Oct. 21, 1904	Stripped and Wet	2 ounces.	Uninjured.	Twigs injured slightly.	Good.	2 to 3 ft.
32	4	Oct. 20. 1904.	Stripped and Wet.	4 ounces.	Uninjured.	All dead to within 1 ft. of ground.	Good.	3 to 4 ft.
40	3	Oct 20, 1904.	Stripped and Wet.	4 ounces.	Uninjured.	Twigs injured.	Good.	2 to 3½ ft.

The peach trees were well grown, as shown at *a*, Fig. 4, and quite well matured, though the leaves did not strip very easily. They were fumigated and handled in other respects as nearly like the apple stock as possible.

The data, as given in the above table, indicate that, even though 4 times the ordinary charge was used in fumigating this stock, no injury was apparent as late as November 11th.

Many of the trees were injured by the exposure of the following winter, but the result on the fumigated and unfumigated trees was exactly the same, and we conclude that this injury was not caused by fumigation.

Effect of Fumigation on Pear Seedlings.

Test No.	No. of Trees in test.	Date of Fumigation.	Amount of Potassium cyanide used to each 100 cu. ft. of air space.	Condition of Stock.		Season's Growth.
				October 26, 1904.	March 23, 1905.	
44	6	Oct 21, 1904.	4 ounces.	Tips killed.	Tips killed.	2 to 2½ ft.
44-a	6	Check.	Unfumigated.	Good.	Same as 44.	2 to 2½ ft.
45	6	Oct. 21, 1904.	4 ounces.	Few twigs killed.	Tips killed.	2 to 4 ft.
45-a	6	Check.	Unfumigated.	Good.	Same as 45.	2 to 4 ft.
46	6	Oct. 21, 1904.	4 ounces.	Extreme tips show injury.	Tips of 2 trees killed back 12 and 14 in.	2 to 4 ft.
46-a	6	Check.	Unfumigated.	Same as 46.	Tips of 2 trees killed back 10 and 18 in.	2 to 4 ft.
47	5	Oct. 21, 1904.	4 ounces.	Extreme tips show marked injury.	Tips of trees killed back 8 to 10 inches.	2 to 4 ft.
47-a	5	Check.	Unfumigated.	Same as 47.	Same as 47.	2 to 4 ft.
48	5	Oct. 22, 1904.	6⅔ ounces.	Tips dead.	Tips of trees killed back 6 to 8 inches.	2 to 2½ ft.
48-a	5	Check.	Unfumigated.	Good.	Tips killed.	2 to 2½ ft.
49	5	Oct. 22, 1904.	6⅔ ounces.	Tips dead.	Tips killed.	2 to 2½ ft.
49-a	5	Check.	Unfumigated	Good.	Same as 49.	2 to 2½ ft.
50	4	Oct. 22, 1904.	6⅔ ounces.	Extreme tips killed.	Tips of 2 trees killed back 8 and 10 in.	2 to 2½ ft.
50-a	5	Check.	Unfumigated.	Good.	Tips shriveled.	2 to 2½ ft.
51	8	Oct. 22. 1904	6⅔ ounces.	Extreme tips killed.	Tips killed.	2 to 2½ ft.
51-a	5	Check.	Unfumigated.	Good.	Same as 51.	2 to 2½ ft.

The pear seedlings used in these tests were grown by W. T. Hood & Co., from seed imported direct from Japan. They averaged about 2 1-2 feet in height, and were very green. The tips of the twigs were almost as soft and tender as the leaves. Part of them were dug on the 21st of October, and part on the 22nd, and all were fumigated the day they were dug.

These seedlings were so green that one would expect the strong charge of gas used to injure them. Only the extreme tips, however, appeared to be injured when examined October 26th.

The following spring when these seedlings were planted, a few of them were dead back from 10 to 18 inches from the top, but this was the case about as often with the unfumigated as with the fumigated trees, and appears to be more the result of the green condition of the stock than of fumigation.

The growth was very good on all of these trees, averaging from 2 to 4 feet in length, and the indications are that pear seedlings may be fumigated at from 2 to 3 times the ordinary strength without fear of injury.

Effect of Fumigating Nursery Stock, April 1st.

Test No.	No. of Trees in Test.	Kind of Stock.	Length of Buds when Fumigated.	Amount of Potassium Cyanide used to each 100 cu. ft. of air space.	Condition of Stock.			Season's Growth.
					April 22, 1905.	June 6, 1905.	August 2, 1905.	
100	5	June Buds—Peach.	½ to ¾ inch.	1 ounce.	Leaves slightly scorched.	Uninjured.	Good.	2 to 3½ ft.
100-a	5	June Buds—Peach.	½ to ¾ inch.	Unfumigated.	Same as 100.	Same as 100.	Same as 100.	2 to 3½ ft.
101	6	June Buds—Peach.	½ inch.	½ ounce.	Uninjured.	Uninjured.	Good.	2 to 2½ ft.
101-a	6	June Buds—Peach.	½ inch.	Unfumigated.	Same as 101.	Same as 101.	Same as 101.	2 to 2½ ft.
102	6	June Buds—Peach.	½ inch.	⅜ ounce.	Uninjured.	Uninjured.	Good.	3 to 4 ft.
102-a	5	June Buds—Peach.	½ inch.	Unfumigated.	Same as 102.	Same as 102.	Same as 102.	3 to 4 ft.
†104	10	1 year Peach.	½ inch.	2 ounces.	Top branches dying.	Tops dead and cut, lower branches healthy.	Good.	2 to 2½ ft.
104-a	5	1 year Peach.	½ inch.	Unfumigated.	Same as 104.	Same as 104.	Same as 104.	2 to 2½ ft.
105	9	1 year Peach.	½ inch.	1 ounce.	Top branches dying.	Tops dead and cut, lower branches healthy.	Good.	2 to 3 ft.
105-a	5	1 year Peach.	½ inch.	*Unfumig't'd.	Fewer dead branches than 105.	Good.	Very good.	2 to 3 ft.
106	6	1 year Peach.	½ inch.	½ ounce.	Top branches dying.	Tops dead and cut back.	Good.	2 to 2½ ft.
106-a	4	1 year Peach.	½ inch.	Unfumigated	Same as 106.	Same as 106.	Same as 106.	2 to 2½ ft.
107	7	1 year Peach.	½ inch.	⅜ ounce.	1 Tree dying, foliage yellow.	1 Tree dead.	Good.	2 ft.
107-a	5	1 year Peach.	½ inch.	Unfumigated.	Same as 107.	Same as 107.	Same as 107.	2 ft.

108	11	2 year Apple, Paradise.	¼ to ½ inch.	2 ounces.	Uninjured.	Good.	Good.	3 to 4 ft.
108-a	5	2 year Apple, Paradise.	¼ to ½ inch.	Unfumigated.	Same as 108.	Same as 108.	Same as 108.	3 to 4 ft.
109	11	2 year Apple, Baldwin.	½ to ¾ inch.	½ ounce.	Uninjured.	Good.	Good.	2 to 2½ ft.
109-a	6	2 year Apple, Baldwin.	½ to ¾ inch.	Unfumigated.	Same as 109.	Same as 109.	Same as 109.	2 to 2½ ft.
110	10	2 year Apple, Early Ripe.	½ to ¾ inch.	1 ounce.	Uninjured.	Good.	Good.	2 to 3 ft.
110-a	5	2 year Apple, Early Ripe.	½ to ¾ inch.	Unfumigated.	Same as 110.	Same as 110.	Same as 110.	2 to 3 ft.
111	11	2 year Apple, Virginia Beauty.	½ to ¾ inch.	½ ounce.	Uninjured.	Good.	Good.	1 to 1½ ft.
111-a	5	2 year Apple, Virginia Beauty.	½ to ¾ inch.	Unfumigated.	Same as 111.	Same as 111.	Same as 111.	1 to 1½ ft.
112	4	1 year Peach, mixed.	½ to ¾ inch.	1 ounce.	Few twigs and branches dead.	Few twigs and branches cut back.	Good.	2½ to 3 ft.
112-a	4	1 year Peach, mixed.	½ to ¾ inch.	Unfumigated.	Same as 112.	Same as 112.	Same as 112.	2½ to 3 ft.
113	4	2 year Cherry, Gov. Wood.	½ to ¾ inch.	1 ounce.	Buds scorched.	Foliage scant, poor condition.	Only 1 tree alive, that in poor condition.	1½ ft.
113-a	3	2 year Cherry, Gov. Wood.	½ to ¾ inch.	Unfumigated.	Trees dying.	All dead.		
114	3	2 year Pear.	½ to ¾ inch.	1 ounce.	Buds stunted.	Fair.	Good.	1 to 1½ ft.

Effect of Fumigating Nursery Stock, April 1st—Continued.

Test No.	No. of Trees in Test.	Kind of Stock.	Length of Buds when Fumigated.	Amount of Potassium Cyanide used to each 100 cu. ft. of air space.	Condition of Stock.			Season s Growth.
					April 22, 1905.	June 6, 1905.	August 2, 1905.	
114-a	2	. . . . .	½ to ¾ inch.	Unfumigated.	Good.	Fair.	Not quite as healthy as 114.	1 to 1½ ft.
115	5	2 year Cherry, Early Richmond.	½ to ¾ inch.	1 ounce.	Poor.	1 Tree dead, others poor.	All dead.	
115-a	8	2 year Cherry. Early Richmond.	½ to ¾ inch.	Unfumigated.	Poor.	1 Tree dead, others poor.	All dead.	

* Trees in this lot were much larger and better, when planted, than those in 105.

† From 104 through 107 were fumigated, fall of 1904, at 1-2-4 strength.

This stock was dug and fumigated very late in the season after the buds had begun to push out. Stock will not stand transplanting at this time with any degree of certainty. Fumigation appeared to have very little effect upon it at this time. The result being practically the same on the checks as on the fumigated stock. The cherry trees died, but practically all the other trees stood the fumigation and made good growth.

FUMIGATION OF GRAFTWOOD.

During January, 1905, the writer had graftwood cut from young orchards of apple located near Blacksburg, Va., for 5,935 apple grafts. These grafts included 35 varieties most commonly planted in this State. The fumigating was done in an oil barrel containing in round numbers, 6 1-2 cubic feet of air space. The barrel appeared to be perfectly tight, but did not have a cover. It was used by simply inverting and placing the open end on the ground, after which the charge was placed underneath and the soil banked around it to prevent the escape of gas. One-half ounce of potassium cyanide was used in fumigating one lot of the graftwood, which was exposed to the gas for forty minutes; for the remainder only 1-4 of an ounce was used. The cyanide, acid and water were used in the proportion of 1-2-4.

In the former case the charge was about 7 1-2 times as strong as that ordinarily used, but in the latter case it was about 3 3-4 times as strong. No injury was noticed at the time.

The soil banked around the opening of this barrel was somewhat porous, and would naturally absorb a considerable amount of the gas, but not enough to reduce its strength to any considerable extent. The grafts showed no injury, and practically all of them united with the root, and were in good condition when planted in April. There were 5,935 grafts planted. Examination in November showed that 3,832, or about 65 per cent. of these grafts were living. While they were planted with a view of testing the results of this fumigation, the writer was unable to give personal attention to the work, and they were not planted as well as they should have been. Yet nurserymen in other parts of the State failed to get as large a per cent. to grow under ordinary conditions, and we conclude that the extra heavy fumigation of this graftwood did not injure it in the least.

These grafts made a splendid growth during the summer, many varieties averaging more than 3 feet in height. This is another indication that the extra heavy charge used in fumigating the graftwood did did not injure it. And, as graftwood is usually fumigated in the dead of winter, when the San Jose scale is most inactive, it would appear to be necessary to use a stronger charge than usually recommended

for nursery stock. The above results indicate that a charge several times the usual strength may be used without danger of injury to well-matured apple twigs in the dead of winter. As 35 varieties were tested in this way, the indications are that almost any variety may be treated in the same manner.

CONCLUSIONS.

First. Unsatisfactory results in fumigating nursery stock have often been due to the use of adulterated potassium cyanide. Often this adulterated cyanide is represented to nurserymen as being pure.

Second. Cyanide of 98 per cent. purity is the only grade that should be used for fumigating purposes.

Adulterated cyanide usually contains sodium chloride. According to Newell the presence of chlorine causes the hydrocyanic acid to break up or decompose. Hence even increased amounts of low grade cyanide cannot be safely substituted for pure cyanide when fumigating nursery stock.

Nurserymen should always require potassium cyanide to be delivered in unbroken packages that bear the guarantee of a reliable company that the contents are of 98 per cent. purity.

Third. The crystalline appearance of potassium cyanide is a good index to its degree of purity, and superficial examination alone often reveals its poor character.

Fourth. Hydrocyanic acid passes off as a gas at the temperature of 80° Fahrenheit. Hence it is necessary to have the temperature of the liquid above this point in generating the gas. Otherwise it would remain behind in the vessel in the liquid state.

Well water is usually about 60° F., but concentrated sulphuric acid, used in the proportion of 1 part to 2 parts of water, raises the temperature about 150 degrees, which is far above the temperature required to volatilize the acid.

The cyanide should be added, however, within a few minutes after the acid so as not to allow time for the temperature of the liquid to fall so near 80 degrees that it would reach that point before all the gas is given off.

Fifth. Outside conditions influence the action, temperature, etc. of small bodies of chemicals more than they do large bodies. Hence fumigating houses, even for fumigating bud and graftwood, should be large enough for the use of at least 1 ounce of cyanide for each charge.

Sixth. Porous soid absorbs so much gas, that it is not advisable to fumigate stock in a pit with earth lining.

Seventh. Fumigation is not likely to kill all the San Jose scale present if stock is packed tightly in the fumigating house, because the gas does not have an opportunity to reach all the insects. The stock should be stood loosely in the house, and the jars should be placed so that there will not be more than 5 or 6 feet from them to the far corners of the room.

Eighth. As apple twigs used for graftwood are usually fumigated in the dead of winter when the San Jose scale is most inactive, consequently harder to kill, we recommend that the charge used for fumigating at this time be increased at least 50 per cent. This would be 1 1-2 ounces of potassium cyanide to each 100 cubic feet of air space in the fumigating room. Graftwood fumigated in the dead of winter when it is fully matured, will stand at least 3 to 4 times the ordinary strength of gas used for fumigating.

Ninth. The indications are that no living San Jose scale passed through the fumigating process alive in our experiments where the stock was wet or where it had been puddled. Yet, as it has been shown that much gas is absorbed by moisture, it is not considered advisable to fumigate stock when it is wet or covered with earth. Neither is it advisable to use less than 1 ounce of potassium cyanide to each 100 cubic feet of air space.

Tenth. About as many eggs hatched on the trees fumigated with the ordinary strength of gas (1 ounce of cyanide to each 100 cubic feet of air space), and weaker charges as on the unfumigated trees. Hence we conclude that fumigation at the ordinary strength of gas has very little value against the eggs of the scurfy scale.

Fumigation with a strength of 1 ounce to 50 cubic feet and 1 ounce to 75 cubic feet may have destroyed the vitality of a few of these eggs, but certainly not enough to make it effective against this insect.

Eleventh. There is no danger of injuring well- matured, deciduous nursery stock even though 2 to 3 times the ordinary strength is used.

If any injury occurs, it is very likely due to the fact that the nursery stock is green, but if it is green enough to be injured by fumigation, it is too green to dig.

Twelfth. Fumigation, April 1st, after the buds had begun to push out, did not appear to injure June buds, one-year peach or two-year apple.

Thirteenth. Some injury observed early in the spring appeared to be caused by winter conditions rather than by fumigation.

Fourteenth. Practically all the stock used in these experiments lived and made good growth, the fumigated trees growing as well as those that were not fumigated.

NOTES ON THRIPS, DISBUDDING INSECT, OR STOPBACK OF PEACH, AS OBSERVED IN THE NURSERIES OF VIRGINIA.

Possibly when more is known in regard to this trouble, some one may coin a name that will be acceptable for it. Heretofore nurserymen have referred to it by various names, chief among which appear to be those given at the head of this article.

The writer has observed many deformed and unsightly peach trees growing in a few of the nurseries of this State during the past few years. Thus far, the trouble appears to have occurred almost entirely in the sandy soils of Eastern Virginia, where the trees grow very rapidly when given proper care. Careful observations during the past summer by my assistants in the nursery inspection work failed to reveal the presence of this trouble to any great extent in other parts of the State. According to Prof. William B. Alwood, recently Entomologist of the Virginia Experiment Station, this trouble was observed by him in Virginia as early as 1901, but nothing appears to have been done toward working out a practical remedy for preventing its ravages.

This trouble has been quite prevalent in New Jersey, as the extended note by Dr. Smith, in the Twelfth Annual Report of the New Jersey Experiment Station will show. Professor Smith attributed it to a species of thrips, which also agrees with Professor Alwood's note quoted by Professor Smith in the same report. Prof. Johnson, recently of the Maryland Experiment Station, attributes the trouble to a mite and states that no thrips had been found causing the injury in that State.

There were very few thrips present at the time examinations were made by the writer, and not once was this insect observed in position to cause the injury. Some of these insects were collected for further study, but, in the rush of other work, they were neglected, and the species was not determined.

A mite was observed to be very plentiful in the tips of the injured trees in a number of instances, and we feel sure that the injury in this case, must be attributed to mites. Some seedling peach trees were collected where there appeared to be no injury and no mites or thrips present. They were planted in pots at Blacksburg about the middle of May. Tops of seedlings that appeared to have been injured by the mites were

placed around the uninjured seedlings in the pots. The result was that the seedlings in the pots soon became injured in the same way, yet no thrips were observed on these plants. No attempt was made to study the form causing the trouble, as the time at our disposal would not permit of it. The species was not even determined, but we hope to take up this study at a later date.

DESCRIPTION OF INJURY.

The average person is not likely to notice anything wrong with the trees until they are injured quite badly. The form causing the injury appears to eat out the growing bud and causes the growth to cease. This injury usually occurs when the plants have but one growing point, and, if they are vigorous, they begin to throw out laterals much more freely than uninjured plants. Fig. 5 shows at the left the typical appearance of injured tree on May 17th, at which time the photograph for this figure was taken. A number of leaves were removed before the photographs were taken, in order to show better the branched appearance. A normal tree is shown at the right in this figure.

The tendency of plants injured in this way is to throw up another main stalk, which starts out a little below the highest bud injured; but the laterals often gain on this central shoot and absorb much the larger part of the nutriment. The resulting tree often appears somewhat dwarfed, and has many branches of nearly the same size, instead of presenting the typical appearance of the peach tree as it should grow in the nursery. This condition is shown at *b* in Fig. 7. A normal peach tree is shown at *a* in the same figure.

Fig. 10. was reproduced from a photograph taken October 30th, and shows the contrast between injured and uninjured trees at the close of the growing season. The tree against which the two-foot rule is leaning was not injured at all, but the other four were injured at heights varying from 9 inches above ground to a little over 3 feet, as indicated by the small piece of cord tied around the tree just below the injury. This figure, however, is not a good reproduction of an injured tree as it should appear without summer pruning, for, where trees grow rapidly as these did, it is necessary to prune many of the side branches during the summer, especially where they have been injured in this way. The points at which the laterals were cut off are plainly visible in this figure. The pruning, in this case, was done by the nurseryman with no idea of trying to produce a straight tree. See Fig. 9, for a contrast between this pruning and the careful pruning with the object of forming straight trees. The trees at *a*, of Fig. 9, are the same as those shown at *b*, in Fig. 7, the photograph, in this case, was taken in October. It will be seen that straight trees were produced by pruning.

EXTENT OF INJURY.

No peach trees had formerly been grown in the soil where these observations were made prior to 1903. In that year a large block of peach was grown on one section of the farm, about four hundred yards distant from the block under discussion.

The plants grew very rapidly at this place, and were from 1 1-2 to 2 feet high on the 17th of May, at the time this examination was made. In the 8,500 plants examined the injury varied from 10 to 20 per cent., depending upon the local conditions. It was much worse in the slight depressions where water stood for a while after heavy rains.

At this time, (May 17th), however, the injury had just begun to show plainly. Later in the season it was found that not more than 20 to 30 per cent. of the trees had escaped injury in many sections of the field. Less than 20 per cent. of the trees were injured in some sections which were located mainly at points where the drainage was good.

A large block of seedling peach, standing about 1-2 to 3-4 of a mile from the budded stock, and just across the fence from the land that grew peach the year before, was examined June 22nd. In the section of seedlings nearest to land that stood in peach the previous year, (just across the fence), 28 per cent. of the plants had been attacked at this date. At another point, about 300 feet from the land that was in peach the previous year, but on a slight knoll where the soil was a little drier, only 14 per cent. of the plants were attacked. But in a lower place, about 900 feet distant, 30 per cent. of the plants were injured.

At this date, (June 22nd), about 80 per cent. of the budded peach had been injured by this trouble in many sections of the field, a much larger percentage than was injured in the seedlings. But as the seedlings were grown and budded on the land the previous year, it is but natural to suppose the injury would be worse in the budded stock.

Data in Regard to Height at which Injury Occurrd on the Trees.

Number of Trees in Row.	Number Uninjured.	Number Injured within 2½ ft. of the ground.	Number Injured between 2½ and 4 ft. above the ground.	Number Injured above 4 ft. from ground.
182	25	25	41	21
43	9	5	29*	. . .
119	64	9	34	12
161	109	6	26	20
225	180	13	24	8
194	128	9	39	28
176	94	14	39	29

* In this case no distinction was made between those injured at this height and those injured at above 4 feet above the ground.

When the writer examined the nursery on May 17th, quite a number of the trees had already been injured, and the indications are that it began about May 12th. The injury occurred at an almost uniform height on the trees for three periods: first, from 1 to 2 feet high about May 12th; second, from 2 1-2 to 3 1-2 feet high about June 12th; third, about 4 feet high. The percentage of trees injured increased with each period, indicating that there must have been several successive broods of the form causing the trouble.

The dividing line between the number injured at 2 1-2 to 4 and above 4 feet was not gauged properly in the latter part of the table; hence the figures in the first line should be considered as much more nearly correct than the others.

STUDY OF METHODS OF CONTROL.

Peach trees attacked in this way are stunted to some extent, but, unless the injury occurs very near the ground, they are about as good as the straight trees. Orchardists now prune away practically all the top, and leave a stump not more than 18 to 20 inches in height, when planting peach trees, and a little crookedness would not be noticed in trees pruned in this way after they had grown in the orchard a few years. Such a large per cent. of trees, however, were injured in this nursery, that it was certainly a very serious affair, for it must be acknowledged that trees injured in this way are quite unsightly. Many planters who have not adopted the methods of close pruning would likely object to them very seriously.

It is usually necessary to prune off some of the lower branches of

peach trees in the nursery during the summer, especially if the trees make a rapid growth, and, upon beginning the study of this trouble, this suggestion almost at once presented itself to the writer: Can trees that are growing rapidly be pruned in such a way as to cause them to grow up very nearly straight, if care is exercised in the pruning? It was also thought that, if the pruning were done at the proper time, very little extra expense would be incurred.

Fig. 5—Young Peach Trees affected with Stopback, on the left. Normal Tree on the right.

The plants were at this time about 18 to 24 inches high, and were growing rapidly except at the points where they were injured. But even here, in most cases, the plants had started a fresh, young growth since being injured. This young growth started up just back of the injured tip, and, in starting out in this way, it necessarily grew out some-

what crooked. In pruning, the object was to cut or pinch off the terminal bud that had ceased to grow, and thus give the side shoot an opportunity to push up almost straight. The tips of the branches were also pinched off so as to throw the main growth into the bud left at the top.

Fig. 6—Peach Trees on left affected with Stopback, after pruning. Normal Tree on the right.

The appearance of injured trees is shown at the left in Fig. 5. Fig. 6 shows the appearance of the same trees after they were pruned. A normal tree is shown to the right in each figure.

Pruning in the middle of June would, however, be necessarily somewhat different from that indicated above, as many branches should be quite large at this time, if the trees have grown well. Fig 7 shows 2 injured trees at this date, and also a tree of normal growth. Fig. 8 shows the 2 trees after they were pruned. The method followed in this case was similar to that of the earlier pruning, except that a number of the larger limbs toward the base of the tree were cut off close to the trunk. This is, however, fully indicated by the cuts.

The photograph of which Fig. 9 is a reproduction, was taken October 30th. The 2 trees shown at *a* are the same ones shown at *b* in Fig. 7. The cord tied around the trunk indicates the point at which the injury occurred. These 2 trees are about as straight as the uninjured ones, while the 2 trees shown at *b* are quite unsightly. This unsightly appearance is shown to better advantage in Fig. 10. The tree against which the two-foot rule is leaning has not been injured.

Fig. 7—*a* Healthy Peach Tree. *b* Peach Trees affected with Stopback.

Data in Regard to Pruning Peach Trees in the Nursery Affected by Stopback.

Variety.	Total No. of Trees in row.	No. injured by May 18.	No. pruned May 18.	No. of crooked Trees Aug. 15.	No of injured Trees that grew up straight.	Percentage of pruned Trees that grew up straight.
Wonderful..	1259	147	147	46	101	68%
Champion..	1010	150	150	40	110	78%
Champion..	1180	183 (June 22.)	Check. (June 22.)	*119		
? ?	160	25	25	3	22	88%

* Sometime after this row was decided upon as a check, it was learned that one of the laborers had pinched a number of trees at one end. This accounts for there being fewer crooked trees than had been injured May 18th.

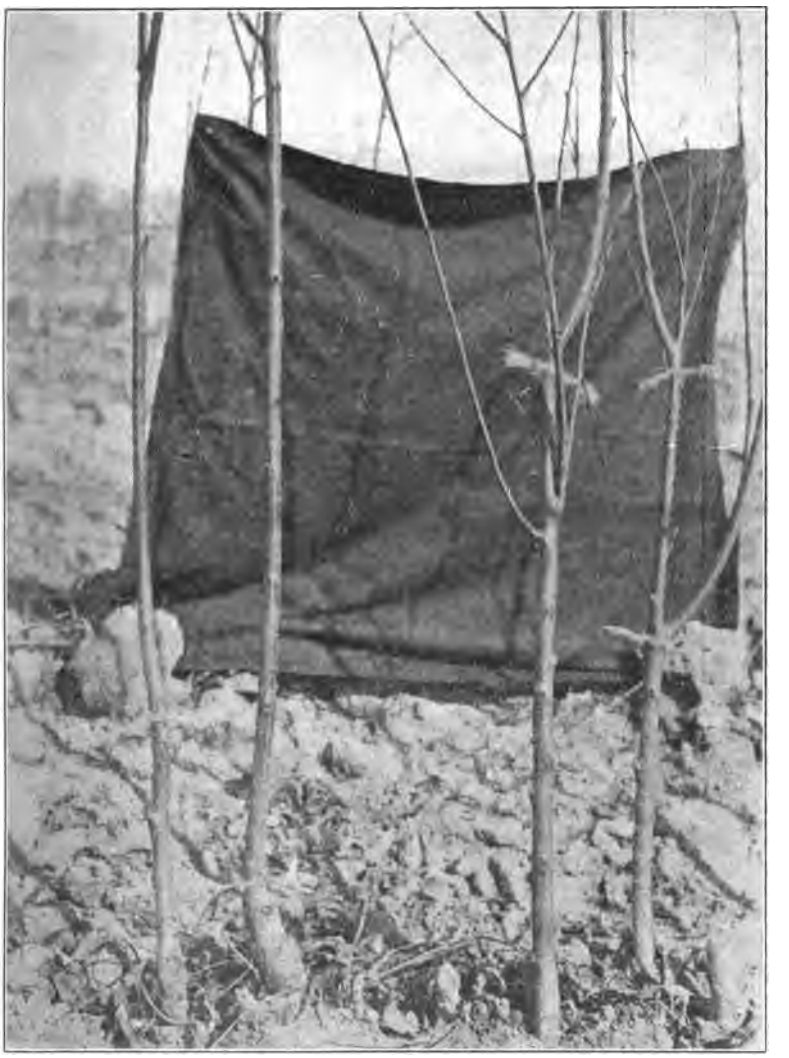
Fig. 8—Peach Trees shown at *b* in Fig. 7, after pruning.

Several rows of peach, containing almost 1,000 trees each, were pruned May 18th, as indicated above for that date. From the data given in the table, it appears that 46 of the trees in the row of Wonderful, pruned May 18th, resulted in crooked trees. This, however, is not exactly the case, as no attention was paid to the pruned trees after the pruning was first done, and some of this injury may have occurred after the pruning was done. The same is true with the row of Champion. Yet it will be noticed that 68 and 75 per cent., respectively, of the injured trees that were pruned, produced trees almost as straight as those that had not been injured.

The remaining trees were not very crooked, yet a little too much so to be called straight trees.

Of the 25 injured trees pruned on June 22nd, (88 per cent. of the total number pruned), produced straight trees. This is greatly in excess of the number of straight trees obtained by the May pruning. The better results obtained at this pruning is accounted for partly by the fact that this trouble could not occur to the lower trunk after this date, and partly because pruning at this date is more effective.

The check row of Champion had only 119 crooked trees on August 15th, while the number attacked on May 18th was 133. The difference here is due to the fact that a laborer in the nursery pinched some of the



a *b*

Fig. 9—*a* Peach Trees shown at *b*, in Fig. 7, after season's growth.
b Peach Trees injured by Stopback.

trees back without our knowing it. And when we found that he had got into our experiment rows it was too late to determine how many trees had been pinched.

Some nurserymen have told me that it is best not to pinch any of the buds, but leave them all to grow so as to afford plenty of food for the form causing the trouble, stating that the buds left would soon be

Fig. 10—1 Year Peach Trees affected with Stopback.

attacked again, and that, because of this fact, the pinching of buds would do no good. We found, however, as indicated above, that the injury is confined mainly to three periods, and that, if the pruning is done at

the proper time between these periods of greatest injury, it will be successful. Care should be taken to allow the buds to start out after the injury occurs before an attempt is made to prune the trees.

CONCLUSIONS.

We were not able to give enough time to the work to have the trees pruned more than once, but the success of this pruning indicates that the trouble can be prevented almost entirely by judicious pruning. Indiscriminate pruning, by an ordinary laborer, is not, however, likely to produce beneficial results.

This work costs but very little in excess of the regular pruning, as both can be done at the same time.

The first pruning should be done about the middle of June.

In order to make it entirely effective, a second pruning should be given a few weeks after the first.

Where this attack occurs in peach trees that are not growing rapidly, the pruning should be supplemented by a dressing of nitrate of soda to promote growth.

Good drainage will likely prevent the trouble in a large measure.

EXPERIMENTS WITH CAUSTIC SODA AND SOME PATENT WASHES AGAINST THE SAN JOSE SCALE.

A report on this work was published October, 1904, by the Virginia Experiment Station as bulletin 152. This report can be obtained upon request, and it does not appear necessary to reprint it at this time. It may be of interest, however, to compare the lime-sulphur wash with the patent washes; hence, we print the portion relating to this and also the conclusions arrived at from the whole work.

COST OF LIME-SULPHUR WASH COMPARED WITH CON-SOL AND KILSCALE.

"The lime-sulphur wash, prepared by using 30 pounds lime, 30 pounds sulphur, and 10 pounds salt to 100 gallons of water, has proven quite effective against the San Jose scale. Should Con-Sol and Kilscale, at a strength of 1 part to 4 parts of water, prove after further trial to be equal in value to the lime-sulphur wash at the strength given above, there would still be the important point of comparative cost to consider before adopting them for orchard work on a commercial scale.

"TABLE IV.—*Comparison of cost of Lime-Sulphur Wash, Con-Sol and Kilscale.*†

Material.	Quantity of material used in wash.	Special gravity at 60° F.	Cost per gallon.
Lime-sulphur wash.	30 lbs. lime. 30 lbs. sulphur. 10 lbs. salt. 100 gallons water.	1.050 to 1.055.	1 to 1¼ cents.
Con-sol, or concentrated lime-sulphur wash.	1 part to 4 parts water.	1.050 to 1.055.	About 20 cents.
Kilscale.	1 part to 6⅔ parts water.		18 to 16 cents depending upon amount purchased.

† The results from the use of caustic soda were so unfavorable that it was not included in this table.

"By consulting the above table it will be seen that Con-Sol and Kilscale each cost much more per gallon than the lime-sulphur wash. Of course, the extra trouble of preparing the lime-sulphur wash is worthy of consideration, but this varies with the facilities for doing such work, and could not be incorporated in the table. The extra cost in any case would not amount to much, and would not nearly offset the heavy first cost to either Kilscale or Con-Sol. The lime-sulphur preparation should, therefore, prove much the cheapest, especially where any large quantity is to be used.

While no solution of Kilscale weaker than 15 per cent. gave satisfactory results in our work, some careful workers report good results

CONCLUSIONS.

"1. Both Con-Sol and Kilscale at a strength of 1 part to 4 parts water proved quite effective against the San Jose scale. This strength of either wash would destroy the foliage, hence these remedies can only be applied during the dormant season.

"2. Kilscale, even at a strength of 1 part to 19 parts water, 5 per cent., injured the foliage of apple trees seriously, and did not kill an appreciable number of scale insects; hence it is not suited to use on fruit trees during the growing season.

"3. While we did not test Con-Sol on the foliage, it resembles the ordinary lime-sulphur wash so closely that it is not considered promising for summer application.

"4. A solution of caustic soda strong enough to have any appreciable effect on the San Jose scale will cause serious injury to fruit trees.

"5. Caustic soda is not recommended for use against the San Jose scale.

"6. The lime-sulphur wash proved as effective as either Con-Sol or Kinscale, and as it can be made on the farm at a much lower cost than either of the others, it is recommended as the most satisfactory for general use."

Manufacturers are continually placing new materials on the market and often make extravagant claims for them. We can not attempt to test all of these materials, for it would take much more time than can be allotted to such work.

The San Jose scale is, at a few periods of the year, very susceptible to outside influences. One of these periods that has come specially under the observation of the writer is very late in the spring, about April 1st, in this latitude. Con-Sol applied on this date the past spring, about twice the strength recommended by the manufacturer, gave fairly good results, but the lime-sulphur wash applied about the same strength, which is 1-4 the strength usually recommended, also gave good results. This being the case, the statement at 6 in the conclusions above holds good in this instance also.

We do not, however, consider that a great amount of work can be done during the few days of the dormant period when this insect is most susceptible to treatment. Hence, we must recommend that the stronger lime-sulphur wash, as outlined in a later section of this report, be adhered to for all orchard work.

THE LIME-SULPHUR WASH.

For method of preparation see pages 32 and 33 of the Fourth Report, and also pages 224 to 226 of bulletin 141. These publications will be mailed upon request.

While it does not appear necessary to republish this matter, there are some phases of the question that were not treated at that time and a brief discussion of some of these points may be of interest.

The wash cooked in small batches over a fire as outlined in the above-mentioned publications will serve every purpose where only a small orchard is to be treated. When a small quantity of materials is used, the chemical action appears to take place better and much less sediment is left to be thrown out of the cooking vats, or to pass over into the spray barrels and clog the nozzles. This idea may not be entirely correct, as the only cases we have observed were such that the wash was cooked at a temperature far below boiling. However, when a

large amount of spraying is to be done, it is advisable to fit up a plant at a convenient location and of sufficient capacity to prepare a large quantity at one time.

Fig 11 was reproduced from a photograph of a steam cooking plant operated in Floyd county. The vats were made by simply cutting off the tops of large casks. The water was brought by gravitation from

STEAM COOKING.

Fig. 11—Steam Plant for Preparing Lime-sulphur Wash.

a nearby spring through the iron pipe shown in cut. A boiler formerly used in a saw-mill furnished the steam.

The steam was let into the liquid through the open end of an iron pipe. This caused all the steam to come out at one place instead of distributing it evenly over the entire cooking mass. A small amount of wash was cooked in these large vats, hence, it covered the bottom thinly and the steam let into it from one opening in the steam pipe

escaped so readily that it had very little time to act on the mass. The temperature of the cooking mass in this case and also in another case, where the conditions were similar, did not rise above 172° Fahrenheit,

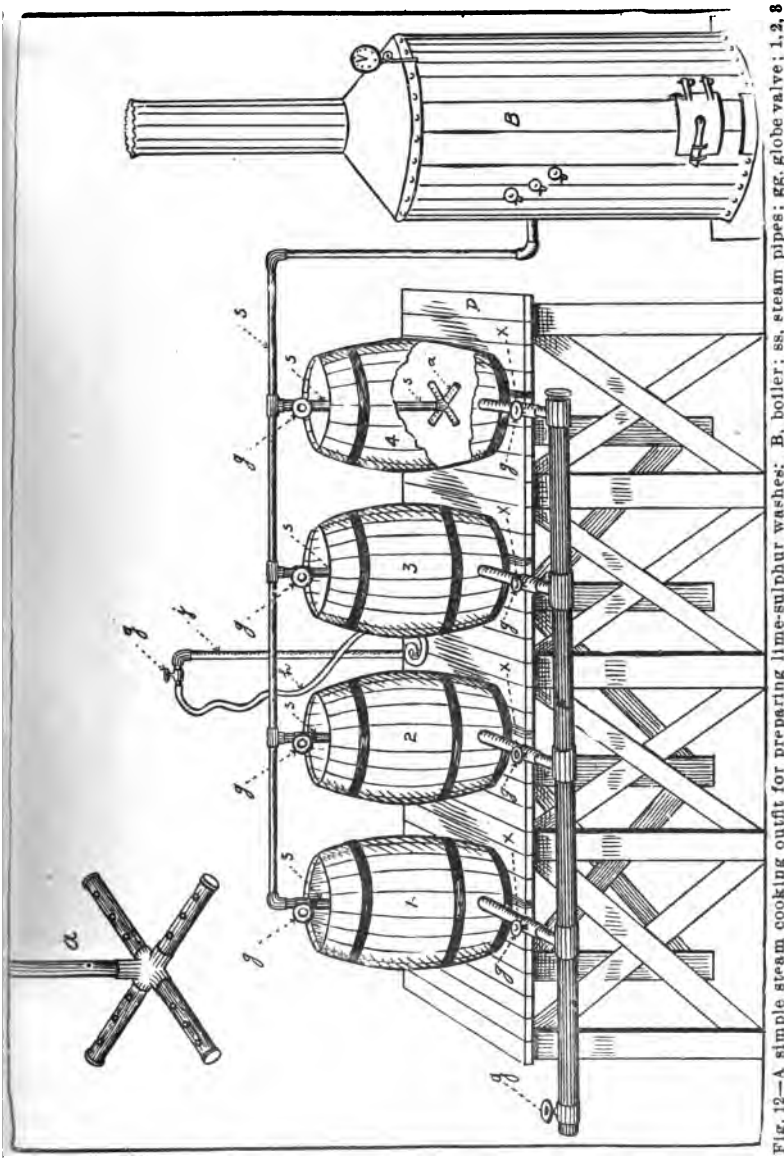


Fig. 12—A simple steam cooking outfit for preparing lime-sulphur washes: B, boiler; ss, steam pipes; gg, globe valve; 1, 2, 3 and 4, 50-gallon barrels; xx, pipes for drawing off mixture after boiling; F large pipe carrying liquid from pipes xx to wagon tank or spray-barrel; a, lower end of steam pipe with crose-arms and one-eighth inch openings for escape of steam; P, platform 6 ft. above ground; j, pipe supplying water from elevated tank or steam jet; h, water hose for carrying clear water to 1, 2, 3 and 4.

which is 38° below the boiling point of water at this altitude. Our experiments show that the temperature of the wash must be raised to the boiling point in order to cook it quickly, and not leave a large amount

of sediment behind. By using a cross-arm, as indicated at *a*, Fig. 12, with a number of small openings, no difficulty is experienced in keeping the liquid at boiling temperature, and a larger proportion of the steam is utilized.

An outfit illustrating a good method of preparation is shown in Fig. 12, taken from bulletin 17, by R. I. Smith, of Georgia. Ordinary kerosene oil barrels will serve very nicely for vats. The steam pipes

Fig. 13--Spraying Outfit.

should be connected so that it will be easy to take them out of the barrels one at a time and allow the sediment to be cleaned out. The portion of the pipe placed in the barrel can be connected with the main steam pipe by rubber hose, if desired. It would then be very easy to remove this portion of the pipe from the barrel.

We wish to call special attention to the cross-arms shown at *a*, in this figure. Openings of 1-8 inch diameter have been drilled in this pipe to distribute the steam instead of allowing all of it to come out at

one or two points. Besides, a larger proportion of it being utilized, the steam escaping in this way helps to agitate the liquid and less stirring is required.

Data on Strength of Lime-Sulphur Wash Obtained by Cooking at Different Temperatures with Live Steam.

Cooking Temperature.	Amount of Precipitate in 500 c. c. of Preparation after Settling.		Specific Pravity of Clear Liquid.
	10 Minutes.	24 Hours.	
80° C.—176° F.	97 c. c.	93 c. c.	1.010
90° C.—194° F.	121 c. c.	95 c. c.	1.011
95° C.—203° F.	115 c. c.	82 c. c.	1.014
98° C.—208° F.	195 c. c.	68 c. c.	1.042

The temperature could not be gauged accurately in obtaining the data for the above table; hence the specific gravity of the clear liquid may vary somewhat from what really should have been obtained. However, this variation should not be enough to account for more than a small per cent of the difference between the preparations cooked at 176 and those cooked at 208 degrees Fahrenheit.

This work appears to indicate conclusively that the temperature must be raised to the boiling point, if a good wash is to be obtained. It may be noted also that the wash cooked at the lower temperature, besides having a very low specific gravity, contains a sediment that settles very rapidly, falling almost as low in 10 minutes as it ever does, while the sediment in the batches cooked at a higher temperature falls very slowly, and is much less in bulk.

HINTS FOR SPRAYING.

Fig. 13 shows a force of men at work, protected very effectively by oil suits. Prof. R. I. Smith advises the use of cheap leather gloves saturated with linseed oil, for protecting the hands.

This cut also illustrates a novel spray cart. The barrel is fixed to the front wheels of a wagon and is drawn by oxen. It forms a good means of getting around in steep orchards. The oxen are protected by a covering of gunny sacking. Fig. 14 shows a portion of above orchard after spraying was completed.

CUMULATIVE EFFECT OF LIME-SULPHUR WASH ON THE SAN JOSE SCALE.

During the summer of 1904 the writer noticed that full grown females did not appear to be producing young. Some of these females

Fig. 14—Orchard well Sprayed with Lime-Sulphur Wash.

taken from trees that had been thoroughly treated with the lime-sulphur wash were examined under the microscope and very few of them were found to be gravid.

Not being fully satisfied with these results, careful examinations were made during the summer of 1905. The following table gives the results of this work:

Result of Microscopical Examinations of Female San Jose Scale after Treatment with the Lime-Sulphur Wash.

Date of Application.	No. and kind of Trees from which specimens were taken.	June 2, 1905.		June 22, 1905.	
		No. of live females examined.	No. of gravid females found.	No. of live females examined.	No. of gravid females found.
December 1, 1904.	25 apple.	354	15	120	8
December 9, 1904.	33 peach.	143	8	52	7
March 27, 1905.	44 peach.	141	0	59	7
March 31, 1905.	26 apple.	No speci	mens foun	d.	
Checks, untreated.	apple.	48	38	12	11
Checks, untreated.	peach.			20	20

These experiments were made to test the value of different kinds of lime-sulphur preparations, there being 13 different mixtures used at this time. In making one of these batches of wash, only 15 pounds of sulphur were used to 100 gallons of water. In all the other cases, however, 30 pounds of sulphur were used, the variation being in the other ingredients, such as salt, copper sulphate, etc.

The results are very decided. In one case where treatment was applied March 27th, 141 females were examined, not one of which was found to be gravid, but the per cent. is somewhat higher in the other lots.

The specimens taken June 20th, however, did not show up nearly so well. It may be that a few of the insects escaped treatment entirely, and that a number of these were examined in this later lot.

The females on the untreated trees were in normal condition at this time, as shown by the large per cent. that were gravid.

These results indicate that the cumulative effect of the lime-sulphur wash is due mainly to the fact that the females coated, but not immediately killed by the wash, fail to produce young. This may be due to one of several causes or partly to each. The wash may kill the males more readily than it does the females, or it may coat them so they cannot readily escape from their scale covering to impregnate the females. Should they escape treatment, the coating over the female may prevent them from reaching her, or the females may be so weakened by the treatment that they fail to produce young.

EFFECTIVENESS.

Since November 30, 1903, at which time bulletin 141 was published, we have continually advised the use of lime-sulphur wash for combating the San Jose scale. The facts, as then set forth, viz.: that this wash prepared in iron kettles of 15 to 20 gallons capacity, cooked vigorously for only 40 minutes, and diluted with cold water, would be just as effective as if it were made by some of the old complicated formulæ, have been fully proven by the past two seasons' work.

We have had quite a number of orchards in different sections of the State treated under our personal directions, using the lime-sulphur wash prepared as above. These orchards were re-examined during the fall of 1904, and, in each case, the trees were found to be quite free from San Jose scale. The wash appears to have come into general use by fruit growers, and, so far as we can learn, is giving satisfaction, so far as results are concerned.

We have not had an opportunity to examine orchards treated with this wash in the moist coast sections of the State, but some of the orchards were treated under varying conditions as to moisture. Several cases are given in detail below.

An orchard, containing apple, pear, and peach trees from 5 to 8 years old, situated near Blacksburg, was treated with the lime-sulphur wash March 23, 1904. The treatment was applied in the afternoon, and a heavy mist began before the work was completed, continuing through the night. The wash did not adhere to the trees as well as usual, and, when examined July 1st, scarcely a trace of it remained. Notwithstanding this fact, the treatment was uniformly effective on apple, pear and peach trees, and when examined in the fall, scarcely a living San Jose scale could be found.

An apple orchard near Dublin, Va., in which the trees ranged from 6 to 12 years of age, was treated on March 7, 1904. The wash in this case adhered to the trees better than in any other that has come under the writer's observation. The coating was plainly visible on a number of the trees when examined October 12, 1904, and, notwithstanding the fact that a number of the trees were badly infested with the San Jose scale when treated, scarcely a living specimen could be found at this date.

Many apple, as well as peach orchards have been examined during the past two years, and not a single case has come to our notice, in which this wash prepared and applied according to directions, failed to protect the orchards from injury.

MATERIALS USED IN PREPARING THE LIME-SULPHUR WASH.

A further study of air-slaked lime indicates that it is worthless for making the lime-sulphur wash, but lime that is only partially air-slaked will, if the quantity is doubled, produce a wash equal in specific gravity and appearance to that made with unslaked lime. The promising results obtained in the earlier work were misleading, because of the fact that the lime was but partially air-slaked. This fact came to light after the report was published. The best quality lime should be used in preparing this wash, as there will be less insoluble material to clog the spray pumps, yet almost any grade of lime can be used if the wash is cooked and strained properly. If poor lime is used, it is advisable to add 1-4 to 1-5 more than recommended in our regular formula.

Sublimated flowers of sulphur and flour sulphur are both prepared from crude brimstone by a process of distillation in which the sulphur is heated until volatilized. It then passes off as vapor, the sand and other impurities remaining behind. Crude ground brimstone of good quality is almost exactly the same, the difference being that purification has not been carried quite so far; hence it contains a slightly larger amount of impurities and a little less pure sulphur. Several samples of sulphur and brimstone recently analyzed* gave the following results:

Flowers of sulphur contained	96%	pure sulphur.
Flour Sulphur contained	97%	" "
Crude ground brimstone contained	94%	" "

Samples of brimstone examined recently contained a large quantity of coarse material, and, though we did not have them analyzed, we feel sure they would not give satisfaction for this purpose. Hence, unless one is very sure of the quality of brimstone, it had better not be used for preparing the lime-sulphur wash. Flour sulphur does not form into pellets as badly in mixing, and, as it gives as good results as the flowers of sulphur and is somewhat cheaper, we consider it a little more desirable for this purpose.

UNCOOKED LIME-SULPHUR WASH.

Much has been written recently about preparing the lime-sulphur wash without cooking. Those who favor this method claim that a good wash may be prepared by carefully utilizing the heat evolved by slaking lime, without resort to fire for additional heat. They also claim that it is not necessary to utilize even all the heat from the slaking lime, if a few pounds of caustic soda is added to the lime and sul-

* Analysis by J. H. Gibboney, Instructor in Chemistry, Virginia Polytechnic Institute.

phur just as the slaking process is completed. We are making a careful study of this method of making the wash, and a partial report on the progress of the work may be of interest. We used 24 pounds of lime, 12 pounds of sulphur, and 40 gallons of water to prepare the batches of wash for this experiment. A double portion of lime was used so as to get as much heat as possible from the slaking process, and 40 gallon quantities were made because of convenience in measuring. The head was taken from a 50-gallon oil barrel, strips nailed across to hold it together, and a small hole cut in the center through which to put a paddle for stirring the mixture. A gunny sack was placed over this top in order better to hold the heat.

As much more heat is evolved from the best lime, quick lime of good quality was secured for this experiment. After careful preliminary tests, it was found that the following method of preparation gave the best results.

Weigh out the lime and sulphur and place in an oil barrel together. Add 10 to 12 gallons of hot water gradually, and stir the mass until the whole is reduced to a thin paste. Then cover the barrel, but take off the cover every 4 or 5 minutes and stir to prevent caking to the bottom.

Handled in this way, the boiling continued from 20 to 40 minutes without boiling over, but considerable experience is necessary to make the wash by this method, and the product is very uncertain. The specific gravity of the resulting wash varied 25 per cent. even when scarcely any difference could be noted in the preparation. It is probable that the variation is mainly caused by the variation in the methods of slaking the lime. The best results were obtained by adding hot water at exactly the right time so as not to allow the lime to get dry or burn. If it gets too dry, scarcely any of the sulphur will be dissolved, and the resulting wash will be very weak. This accounts for the variation in specific gravity of the preparations given in the following table:

Data on Preparation of Cooked and Uncooked Lime-Sulphur Wash, Varied by Use of Caustic Soda.

Test No.	Quantities Used.				Method of Preparation.	Slaking Lime kept mixture boiling.	Specific gravity of wash at 20° C.
	Lime.	Sulphur	Caustic Soda.	Water.			
105	24 lbs.	12 lbs.	. . . .	40 gal.	With hot water in covered barrel.	25 minutes.	1.036
109	24 lbs.	12 lbs.	. . . .	40 gal.	With hot water in covered barrel.	80 minutes.	1.036
112	24 lbs.	12 lbs.	. . . .	40 gal.	With hot water in covered barrel.	. . . . .	1.032
106	24 lbs.	12 lbs.	1 lb.	40 gal.	With hot water in covered barrel.	15 minutes.	1.026
110	24 lbs.	12 lbs	1 lb.	40 gal.	With hot water in covered barrel.	20 minutes.	1.036
107	24 lbs.	12 lbs.	8 lb.	40 gal.	With hot water in covered barrel.	25 to 30 min.	1.048
108	24 lbs.	12 lbs.	4 lbs.	40 gal.	With hot water in covered barrel.	20 minutes.	1.027
111	24 lbs.	12 lbs.	4 lbs.	40 gal.	With hot water in covered barrel.	20 minutes.	1.032
113	24 lbs.	12 lbs.	. . . .	40 gal.	Cooked over flame 40 minutes.	. . . . .	1.048

A study of the table indicates that the strongest lime-sulphur wash is obtained by boiling. It also indicates that caustic soda does not add to the strength of the wash; in fact, the resulting wash varied much more with than without the soda. Of the five trials made with caustic soda, only 2 resulted in preparations as strong as those obtained without it.

Field trials indicated that the lime-sulphur wash prepared by the barrel method is successful against the San Jose scale if the strength of the liquid reaches a specific gravity of about 1.036 or about 5 1-2 degrees on the Beume acid spindle. However, the strongest wash made by this method is 16 per cent. weaker than the cooked wash, while the poorest batch is almost 30 per cent. weaker, and several times an entire failure resulted in trying to prepare the wash by this method. The failures were mainly due to the fact that the hot water was not added at exactly the proper time.

It is necessary to use hot water in preparing this so-called uncooked wash, and practically as much time is consumed in making it as in making the regular lime-sulphur wash, hence we cannot see how any saving of expense or trouble could be realized by its use even under the best conditions.

J. L. PHILLIPS,
State Entomologist and Plant Pathologist.

TABULATED STATEMENT OF EXPENSES.

GENERAL EXPENSE ACCOUNT.

November 4, 1903.

J. L. Phillips, salary, voucher No. 137	$	125 00
R. B. Carruthers, salary, voucher No. 139		40 00
W. B. Alwood, salary, voucher No. 140		25 00
J. L. Phillips, expenses field work, voucher No. 142		5 50
W. B. Alwood, expenses field work, voucher No. 141		6 35
E. F. Cole, expenses field work, voucher No. 148		21 75
Photographic work and drawings, voucher No. 155, 156, 161		26 80
Labor, voucher No. 149, 157		6 10
Office and laboratory supplies, voucher No. 150, 152, 158-160		34 53
Printing, voucher No. 151, 154		54 05
Express and hauling, voucher No. 153		6 96
Telegrams, voucher No. 143		1 50
Postage, voucher No. 146, 147		20 00
Total	$	373 54

December 4, 1903.

J. L. Phillips, salary, voucher No. 162	$	125 00
W. J. Phillips, salary, voucher No. 163		75 00
R. B. Carruthers, salary, voucher No. 164		40 00
W. B. Alwood, salary, voucher No. 165		25 00
W. B. Alwood, expenses field work, voucher No. 170		11 45
C. E. Craig, expenses field work, voucher No. 168		2 50
Labor, voucher No. 166, 167, 173		12 60
Drawings, voucher No. 171		11 10
Office supplies, voucher No. 172, 180, 181, 184, 185		8 56
Printing, voucher No. 182, 183		37 37
Freight and express, voucher No. 179		3 37
'Phone rent and telegrams, voucher No. 169, 175		19 30
Postage, voucher No. 174		5 00
Subtract error in account J. P. Effinger, August 3, 1903		376 25
Total	$	376 19

December 17, 1903.

J. L. Phillips, salary, voucher No. 186	$	125 00
W. J. Phillips, salary, voucher No. 187		75 00
R. B. Carruthers, salary, voucher No. 188		40 00
W. B. Alwood, salary, voucher No. 189		25 00
E. F. Cole, salary, voucher No. 191		40 00
J. L. Phillips, expenses field work, voucher No. 192		7 30
E. F. Cole, expenses field work, voucher No. 190		53 74
Clerical services, voucher No. 195		1 55

Labor, voucher No. 194	$	8 00
Printing, voucher No. 193, 196		59 15
Total	$	434 74

February 3, 1904.

J. L. Phillips, salary, voucher No. 202	$	125 00
W. J. Phillips, salary, voucher No. 203		75 00
R. B. Carruthers, salary, voucher No. 204		40 00
W. B. Alwood, salary, voucher No. 205		25 00
J. L. Phillips, expenses field work, voucher No. 207		16 20
W. J. Phillips, expenses field work, voucher No. 206		76 53
W. B. Alwood, expenses field work, voucher No. 219		6 79
E. F. Cole, expenses field work, voucher No. 217, 218		52 55
Labor, voucher No. 214		10 00
Office supplies, voucher No. 210, 211, 220, 221, 223		17 77
Printing, voucher No. 200, 222		9 25
Express and hauling, voucher No. 209, 212, 213		8 83
Telegrams, voucher No. 208		3 64
Postage, voucher No. 201, 215, 216		15 00
Total	$	481 56

March 3, 1904.

J. L. Phillips, salary, voucher No. 226	$	125 00
W. J. Phillips, salary, voucher No. 227		75 00
R. B. Carruthers, salary, voucher No. 228		40 00
W. B. Alwood, salary, voucher No. 229		25 00
E. F. Cole, salary, voucher No. 231		40 00
J. L. Phillips, expenses field work, voucher No. 233		51 82
W. J. Phillips, expenses field work, voucher No. 232		85 31
E. F. Cole, expenses field work, voucher No. 230		60 55
Labor, voucher No. 236, 237, 239		12 20
Office supplies, voucher No. 240, 241		9 23
Printing, voucher No. 235		11 85
Telegrams, voucher No. 234		1 97
Postage, voucher No. 238		5 00
Total	$	542 93

April 4, 1904.

J. L. Phillips, salary, voucher No. 242	$	125 00
W. J. Phillips, salary, voucher No. 243		75 00
R. B. Carruthers, salary, voucher No. 244		45 00
E. F. Cole, salary, voucher No. 249		40 00
W. B. Alwood, salary, voucher No. 245		25 00
J. L. Phillips, expenses field work, voucher No. 246		50 60
W. J. Phillips, expenses field work, voucher No. 247		84 79
E. F. Cole, expenses field work, voucher No. 248		39 95

Labor, voucher No. 251	$ 9 25
Office supplies, voucher No. 264	1 10
Printing, voucher No. 253, 254, 261-263, 265	162 20
Express and hauling, voucher No. 255	12 83
'Phone rent and telegrams, voucher No. 250, 252	7 56
Postage, voucher No. 256-258	15 00
Total	$ 693 28

May 4, 1904.

J. L. Phillips, salary, voucher No. 273	$ 125 00
R. B. Carruthers, salary, voucher No. 274	45 00
W. B. Alwood, salary, voucher No. 275	25 00
E. F. Cole, expenses field work, voucher No. 267	36 05
Office and laboratory supplies, voucher No. 277, 283, 285	8 38
Printing, voucher No. 284	10 50
Express and hauling, voucher No. 278	3 28
Telegrams, voucher No. 276	2 89
Postage, voucher No. 279, 280	10 00
Total	$ 266 10

May 27, 1904.

J. L. Phillips, salary, voucher No. 286	$ 125 00
W. J. Phillips, salary, voucher No. 287	75 00
R. B. Carruthers, salary, voucher No. 288	45 00
W. B. Alwood, salary, voucher No. 289	25 00
C. I. Wade, salary for year ending May 1, 1904, voucher No. 307	150 00
W. J. Phillips, expenses field work, voucher No. 290	54 5
W. B. Alwood, expenses field work, voucher No. 296	4 50
Clerical services, voucher No. 294	10 00
Labor, voucher No. 295	8 00
Office and laboratory supplies, voucher No. 301, 303, 304	17 34
Printing, voucher No. 293, 302	27 55
Express and hauling, voucher No. 292	3 75
'Phone rent and telegrams, voucher No. 291, 297	6 71
Postage, voucher No. 298-300	15 00
Total	$ 567 38

July 2, 1904.

J. L. Phillips, salary, voucher No. 308	$ 125 00
W. J. Phillips, salary, voucher No. 309	75 00
R. B. Carruthers, salary, voucher No. 310	45 00
W. B. Alwood, salary, voucher No. 311	25 00
C. I. Wade, salary for May and June, voucher No. 312	25 00
W. J. Phillips, expenses field work, voucher No. 314	18 54
Clerical services, voucher No. 313, 315	14 00
Labor, voucher No. 316	5 00

Office supplies, voucher No. 317, 322-326	$	56 81
Express and hauling, voucher No. 318		4 74
Postage, voucher No. 319-321		15 00
Total	$	409 09

August 3, 1904.

J. L. Phillips, salary, voucher No. 329	$	125 00
W. J. Phillips, salary, voucher No. 330		75 00
R. B. Carruthers, salary, voucher No. 331		41 67
W. B. Alwood, salary, voucher No. 332		25 00
Harper Dean, Jr., salary, voucher No. 344		25 00
C. I. Wade, salary, voucher No. 333		12 50
J. L. Phillips, expenses field work, voucher No. 336		81 57
Harper Dean, Jr., expenses field work, voucher No. 350		119 68
C. E. Craig, laboratory work, voucher No. 340		17 00
Clerical services, voucher No. 342		10 00
Labor, voucher No. 343		5 00
Office and laboratory supplies, voucher No. 338, 345, 348, 351-353, 355		31 12
Printing, voucher No. 341, 349, 354, 356		47 75
Express and hauling, voucher No. 339		7 95
'Phone rent and telegrams, voucher No. 335, 337		3 59
Postage, voucher No. 334, 346, 347		15 00
Total	$	642 83

September 3, 1904.

J. L. Phillips, salary, voucher No. 357	$	125 00
W. J. Phillips, salary, voucher No. 358		75 00
R. B. Carruthers, salary, voucher No. 359		41 66
W. B. Alwood, salary, voucher No. 360		25 00
C. I. Wade, salary, voucher No. 361		12 50
J. L. Phillips, expenses field work, voucher No. 369		69 95
C. E. Craig, laboratory work, voucher No. 365		35 00
Clerical services, voucher No. 367, 368, 372		22 00
Labor, voucher No. 366		5 00
Office and labor supplies, voucher No. 373-376		21 32
Postage, voucher No. 370, 371		10 00
Total	$	442 43

October 4, 1904.

J. L. Phillips, salary, voucher No. 377	$	125 00
W. J. Phillips, salary, voucher No. 384		75 00
R. B. Carruthers, salary, voucher No. 378		41 67
Harper Dean, Jr., salary, voucher No. 381		40 00
W. W. Chase, salary, voucher No. 385		25 00
C. I. Wade, salary, voucher No. 379		12 50
J. H. Gibboney, chemical work, voucher No. 387		25 00

Clerical services, voucher No. 383	$	15 00
Labor, voucher No. 390		5 00
Office and labor supplies, voucher No. 388, 395, 396		25 81
Printing, voucher No. 389		12 75
Express and hauling, voucher No. 391		3 00
Postage, voucher No. 392-394		16 00
Total	$	421 73

November 4, 1904.

J. L. Phillips, salary, voucher No. 397	$	125 00
R. B. Carruthers, salary, voucher No. 398		41 67
Harper Dean, Jr., salary, voucher No. 404		40 00
W. W. Chase, salary, voucher No. 402		25 00
C. I. Wade, salary, voucher No. 399		12 50
J. L. Phillips, expenses field work, voucher No. 408		34 98
Harper Dean, Jr., expenses field work, voucher No. 407		64 55
C. E. Craig, laboratory work, voucher No. 401		14 00
J. H. Gibboney, chemical work, voucher No. 400		12 50
Clerical services, voucher No. 403		20 00
Labor, voucher No. 405, 409		10 50
Office and laboratory supplies, voucher No. 414, 418, 419, 422		98 45
Printing, voucher No. 411, 415, 417, 420, 421		143 75
Express and livery service, voucher No. 406, 410, 416		22 46
Telegrams, voucher No. 412		1 09
Postage, voucher No. 413		30 00
Total	$	696 45

December 3, 1904.

J. L. Phillips, salary, voucher No. 423	$	125 00
R. B. Carruthers, salary, voucher No. 424		41 66
C. I. Wade, salary, voucher No. 425		12 50
Harper Dean, Jr., salary, voucher No. 433		40 00
Harper Dean, Jr., expenses field work, voucher No. 432		151 31
J. H. Gibboney, chemical work, voucher No. 435		25 00
C. E. Craig, field and office work, voucher No. 430		35 00
J. C. Stiles, field and office work, voucher No. 434		20 00
Clerical services, voucher No. 431		18 00
Labor, voucher No. 436, 453		15 75
Office and laboratory supplies, voucher No. 443, 446, 448-452, 457		71 86
Printing, voucher No. 454		10 50
Express and livery service, voucher No. 439, 447, 455		19 97
'Phone rent and telegrams, voucher No. 437, 444		8 42
Postage, voucher No. 445		15 00
Total	$	609 97

December 21, 1904.

J. L. Phillips, salary, voucher No. 465	$	125 00
R. B. Carruthers, salary, voucher No. 466		41 66
Harper Dean, Jr., salary, voucher No. 470		40 00

C. I. Wade, salary, voucher No. 467	$	12 50
J. L. Phillips, expenses field work, voucher No. 469		17 45
Harper Dean, Jr., expenses field work, voucher No. 471		15 75
J. C. Stiles, expenses field work, voucher No. 473		11 70
C. E. Craig, expenses field work, voucher No. 479		30 33
C. E. Craig, field and office work, voucher No. 475		25 00
J. C. Stiles, field and office work, voucher No. 472		20 00
J. H. Gibboney, chemical work, voucher No. 474		25 00
Clerical services, voucher No. 468		16 50
Labor, voucher No. 476		7 00
J. H. Heavener, field work and expenses, voucher No. 477, 478		19 70
Office and laboratory supplies, voucher No. 486-488, 491		31 19
Printing, voucher No. 489		6 00
Livery service, voucher No. 490		4 00
Postage, voucher No. 480-482		17 50
Total	$	466 28

February 3, 1905.

J. L. Phillips, salary, voucher No. 492	$	125 00
C. I. Wade, salary, voucher No. 493		12 50
Harper Dean, Jr., salary, voucher No. 497		50 00
J. L. Phillips, expenses field work, voucher No. 496		50 78
J. H. Gibboney, chemical work, voucher No. 511		25 00
Clerical services, voucher No. 498, 500, 508, 510		47 25
Labor, voucher No. 504, 505		8 70
Office and laboratory supplies, voucher No. 502, 503, 509, 516, 519-522		63 84
Printing, voucher No. 501, 517, 518		24 80
Freight and express, voucher No. 494, 495, 499, 506		39 10
Telegrams, voucher No. 507		2 25
Postage, voucher No. 512-515		68 00
Total	$	517 22

March 6, 1905.

J. L. Phillips, salary, voucher No. 526	$	125 00
C. I. Wade, salary, voucher No. 527		12 50
Harper Dean, Jr., salary, voucher No. 537		50 00
C. E. Craig, laboratory work, voucher No. 535		12 15
J. H. Gibboney, chemical work, voucher No. 538		25 00
Harper Dean, Jr., expenses field work, voucher No. 539		62 47
Clerical services, voucher No. 529, 530, 542		37 40
Labor, voucher No. 528, 531, 534, 553		29 70
Office and laboratory supplies, voucher No. 533, 540, 541, 544, 548, 550-552, 554		39 35
Printing, voucher No. 543, 547, 549		20 18
Freight and express, voucher No. 536		6 83
'Phone rent, voucher No. 532		3 13
Postage, voucher No. 545, 546		10 00
Total	$	433 71

April 3, 1905.

J. L. Phillips, salary, voucher No. 555	$	125 00
Harper Dean, Jr., salary, voucher No. 558		50 00
J. C. Stiles, salary, voucher No. 561		40 00
C. I. Wade, salary, voucher No. 556		12 50
J. L. Phillips, expenses field work, voucher No. 559		24 10
Harper Dean, Jr., expenses field work, voucher No. 557		28 30
J. C. Stiles, expenses field work, voucher No. 560		55 25
J. H. Gibboney, chemical work, voucher No. 564		12 50
Clerical services, voucher No. 562, 571		45 00
Labor, voucher No. 563, 565-570		23 90
Office and laboratory supplies, voucher No. 576-583		27 05
Printing, voucher No. 575		53 66
Freight and express, voucher No. 572		9 63
Telegrams, voucher No. 573		5 19
Postage, voucher No. 574		5 00
Total	$	517 08

May 4, 1905.

J. L. Phillips, salary, voucher No. 586	$	125 00
J. C. Stiles, salary, voucher No. 599		40 00
C. I. Wade, salary, voucher No. 587		12 50
Clerical services, voucher No. 597, 598		45 00
Labor, voucher No. 590-593, 604		16 95
Office and laboratory supplies, voucher No. 589, 594-596, 603		31 35
Postage, voucher No. 602		5 00
Total	$	275 80

June 5, 1905.

J. L. Phillips, salary, voucher No. 610	$	125 00
M. H. Stiff, salary, voucher No. 615		30 00
J. C. Stiles, salary, voucher No. 614		40 00
C. I. Wade, salary, voucher No. 611		12 50
J. L. Phillips, expenses field work, voucher No. 613		92 95
J. C. Stiles, expenses field work, voucher No. 625		91 89
C. E. Craig, expenses field work, voucher No. 620		22 50
C. E. Craig, laboratory and field work, voucher No. 619		49 00
Clerical services, voucher No. 617, 618		31 00
Labor, voucher No. 616, 624		16 35
Office and laboratory supplies, voucher No. 629, 630, 632, 633		15 66
Printing, voucher No. 623, 631		127 00
Express and livery service, voucher No. 621, 622		3 81
Telegrams, voucher No. 612		3 27
Postage, voucher No. 626-628, 634		20 00
Total	$	680 93

July 3, 1905.

J. L. Phillips, salary, voucher No. 638	$	125 00
J. C. Stiles, salary, voucher No. 644		40 00
M. H. Stiff, salary, voucher No. 643		35 00
C. I. Wade, salary, voucher No. 639		12 50
C. E. Craig, field and laboratory work, voucher No. 641		35 00
J .L. Phillips, expenses field work, voucher No. 658		38 80
J. C. Stiles, expenses field work, voucher No. 659		71 09
C. E. Craig, expenses field work, voucher No. 642		18 80
Clerical services, voucher No. 640		25 70
Labor, voucher No. 647		7 50
Office supplies, voucher No. 649, 651-655		29 18
Printing, voucher No. 657		10 00
Express, voucher No. 656		4 93
'Phone rent, voucher No. 648		3 12
Postage, voucher No. 645, 646		10 00
Total	$	466 62

August 4, 1905.

J. L. Phillips, salary, voucher No. 660	$	125 00
J. C. Stiles, salary, voucher No. 662		40 00
W. J. Price, salary, voucher No. 661		60 00
M. H. Stiff, salary, voucher No. 663		40 00
C. I. Wade, salary, voucher No. 664		12 50
C. E. Craig, field and office work, voucher No. 675		19 00
J. C. Stiles, expenses field work, voucher No. 674		68 68
Clerical services, voucher No. 670		29 20
Labor, voucher No. 671, 672		14 75
Office supplies, voucher No. 676-679		93 79
Printing, voucher No. 673		24 27
Postage, voucher No. 665, 666, 669		30 00
Total	$	557 19

September 4, 1905.

J. L. Phillips, salary, voucher No. 680	$	125 00
J. C. Stiles, salary, voucher No. 682		40 00
W. J. Price, salary, voucher No. 681		60 00
M. H. Stiff, salary, voucher No. 683		40 00
C. I. Wade, salary, voucher No. 684		12 50
C. E. Craig, laboratory and field work, voucher No. 693		30 00
J. H. Gibboney, chemical work, voucher No. 690		30 00
J. L. Phillips, expenses field work, voucher No. 685		76 55
C. E. Craig, expenses field work, voucher No. 694		19 00
A. C. Turner, field work and expenses, voucher No. 701		47 00
Clerical services, voucher No. 691, 696		40 50
Labor, voucher No. 692, 702		9 90
Office supplies, voucher No. 695, 703, 704		30 11

Printing, voucher No. 698, 705, 706	$	64 05
Express and hauling, voucher No. 689		14 85
Underwood Typewriter Co. exchange on typewriter, voucher No. 707		48 62
'Phone rent, voucher No. 697		3 13
Postage, voucher No. 686, 699		35 00
Total	$	726 21

October 3, 1905.

J. L. Phillips, salary, voucher No. 708	$	125 00
J. C. Stiles, salary, voucher No. 710		40 00
W. J. Price, salary, voucher No. 709		60 00
M. H. Stiff, salary, voucher No. 711		40 00
C. I. Wade, salary, voucher No. 712		12 50
C. E. Craig, laboratory and field work, voucher No. 717		35 00
J. H. Gibboney, chemical work, voucher No. 719		30 00
J. C. Stiles, expenses field work, voucher No. 718		63 36
C. E. Craig, expenses field work, voucher No. 716		52 33
M. H. Stiff, expenses and notary fees, voucher No. 728		6 70
Clerical services, voucher No. 715, 720		79 00
Labor, voucher No. 721, 722		4 50
Office and laboratory supplies, voucher No. 723, 725, 730-733, 736-739		82 08
Printing, voucher No. 729, 734, 735		22 00
Express, voucher No. 724		7 12
Postage, voucher No. 714, 727		18 19
Total	$	677 78

EXPENSES NURSERY INSPECTION.

November 4, 1903.

W. J. Phillips, salary, voucher No. 138	$	75 00
W. J. Phillips, expenses field work, voucher No. 144, 145		89 60
Total	$	164 60

December 4, 1903.

J. L. Phillips, expenses field work, voucher No. 177	$	76 55
W. J. Phillips, expenses field work, voucher No. 176		90 99
J. H. Heavener, expenses field work, voucher No. 178		5 20
Total	$	172 74

December 17, 1903.

T. J. Dolen, field work, voucher No. 197	$	1 50
A. C. Turner, inspection nursery stock, voucher No. 199		6 40
G. M. Thacker, field work and expenses, voucher No. 198		17 25
Total	$	25 15

February 3, 1904.

R. A. Burks, inspection nursery stock, voucher No. 224	$	8 50
A. C. Turner, inspection nursery stock, voucher No. 225		1 50
Total	$	10 00

April 4, 1904.

A. C. Turner, inspection nursery stock, voucher No. 260	$	7 00
W. W. Tanquary, inspection nursery stock, voucher No. 259		5 00
Total	$	12 00

May 4, 1904.

J. L. Phillips, expenses field work, voucher No. 266	$	61 00
W. J. Phillips, expenses field work, voucher No. 269		23 59
W. J. Phillips, salary, voucher No. 272		75 00
E. F. Cole, salary, voucher No. 268		30 00
A. C. Turner, inspection nursery stock, voucher No. 281		3 70
W. W. Tanquary, inspection nursery stock, voucher No. 282		10 00
Clerical services, voucher No. 270		90
Labor, voucher No. 271		8 00
Total	$	212 19

May 27, 1904.

A. C. Turner, inspection nursery stock, voucher No. 305	$	4 75
S. W. Cole, inspection nursery stock, voucher No. 306		8 00
Total	$	12 75

July 2, 1904.

S. W. Cole, inspection nursery stock, voucher No. 327	$	3 00
W. W. Tanquary, inspection nursery stock, voucher No. 328		5 00
Total	$	8 00

September 3, 1904.

Harper Dean, Jr., salary, voucher No. 364	$	40 00
Harper Dean, Jr., expenses field work, voucher No. 362		80 05
W. J. Phillips, expenses field work, voucher No. 363		36 20
Total	$	156 25

October 4, 1904.

J. L. Phillips, expenses field work, voucher No. 382	$	91 37
Harper Dean, Jr., expenses field work, voucher No. 380		90 95
W. W. Chase, expenses field work, voucher No. 386		78 35
Total	$	260 67

December 3, 1904.

J. L. Phillips, expenses inspection work, voucher No. 428	$	47 44
C. E. Craig, expenses inspection work, voucher No. 427		29 55
W. W. Chase, expenses nursery inspection, voucher No. 426		49 05
J. H. Heavener, expenses nursery inspection, voucher No. 442		38 80
W. W. Chase, expenses nursery inspection for October, voucher No. 429		93 00
A. C. Turner, inspection nursery stock, voucher No. 464		7 00
J. A. Snavely, inspection nursery stock, voucher No. 462		5 50
J. H. Heavener, inspection nursery stock, voucher No. 441		15 00
H. N. Harrison, inspection nursery stock, voucher No. 459		4 00
G. D. Clemmer, inspection nursery stock, voucher No. 458		1 85
J. T. Harman, inspection nursery stock, voucher No. 460		2 00
J. A. Naff, inspection nursery stock, voucher No. 461		5 00
W. W. Tanquary, inspection nursery stock, voucher No. 463		8 75
W. W. Chase, field work, voucher No. 440		25 00
Total	$	331 94

December 21, 1904.

J. B. Coffman, inspection nursery stock, voucher No. 485	$	9 20
H. C. Rosenberger, inspection nursery stock, voucher No. 484		11 49
G. F. Pultz, inspection nursery stock, voucher No. 483		2 00
Total	$	22 69

February 3, 1905.

R. A. Burks, inspection nursery stock, voucher No. 523	$	3 50
G. M. Thacker, inspection nursery stock, voucher No. 525		5 00
W. R. Huffard, inspection nursery stock, voucher No. 524		4 00
Total	$	12 50

April 3, 1905.

S. W. Cole, inspection nursery stock, voucher No. 585	$	10 00
A. C. Turner, inspection nursery stock, voucher No. 584		2 25
Total	$	12 25

May 4, 1905.

J. L. Phillips, expenses nursery inspection, voucher No. 588	$	22 40
J. C. Stiles, expenses nursery inspection, voucher No. 600		48 66
C. E. Craig, expenses nursery inspection, voucher No. 601		67 60
R. A. Burks, inspection nursery stock, voucher No. 609		4 75
J. B. Coffman, inspection nursery stock, voucher No. 606		15 50
A. C. Turner, inspection nursery stock, voucher No. 608		18 00
W. W. Tanquary, inspection nursery stock, voucher No. 605, 607		12 50
Total	$	189 41

June 5, 1905.

T. J. Dolen, inspection nursery stock, voucher No. 635	$	1 50
S. W. Cole, inspection nursery stock, voucher No. 637		9 25
W. H. Poff, inspection nursery stock, voucher No. 636		8 00
Total	$	18 75

August 4, 1905.

J. L. Phillips, expenses nursery inspection, voucher No. 668	$	9 85
W. J. Price, expenses nursery inspection, voucher No. 667	$	89 43
Total	$	99 28

September 4, 1905.

J. C. Stiles, expenses field work, voucher No. 687	$	109 18
W. J. Price, expenses field work, voucher No. 688		58 23
W. R. Huffard, field work and expenses, voucher No. 700		5 00
Total	$	172 41

October 3, 1905.

J. L. Phillips, expenses field work, voucher No. 713	$	29 15
W. J. Price, expenses field work, voucher No. 726		109 10
G. M. Thacker, inspection nursery stock, voucher No. 740		4 00
Total	$	142 25

SUMMARY.

Amount on hand October 1, 1903	$ 379 75	
Fees from Nurserymen (2 fiscal years ending October 1, 1905)	3,880 00	
Appropriations (2 fiscal years ending October 1, 1905)	12,000 00	
Total		$ 16,259 75
*Expenses (general account)	$ 12,277 04	
*Expenses (nursery inspection)	2,035 83	
Total expenses		$ 14,312 87
Amount on hand		$ 1,946 88

*The auditor rules that the appropriation year begins May 9th, and ends May 9th, of the following year, hence it does not coincide with the period covered by this report.

ILLUSTRATIONS.

Fig. 1—Diseased apple tree roots.

Fig. 2—Healthy apple tree roots.

Fig. 3—Apple tree with roots cut.

Fig. 4—(*a*) 1 year peach; (*b*) 1 year budded apple; (*c*) 2 year grafted apple.

Fig. 5—Young peach trees affected with stopback on the left; normal tree on the right.

Fig. 6—Peach trees on left affected with stopback, after pruning; normal tree on the right.

Fig. 7—(*a*) Healthy peach tree; (*b*) peach trees affected with stopback.

Fig. 8—Peach tree at(*b*) in Fig. 7, after pruning.

Fig. 9—(*a*) Peach trees shown at (*b*) Fig. 7, after season's growth; (*b*) peach trees injured by stopback.

Fig. 10—1 year peach trees, affected with stopback.

Fig. 11—Steam plant for preparing lime-sulphur wash.

Fig. 12—Steam cooking outfit for preparing lime-sulphur washes.

Fig. 13—Spraying outfit.

Fig. 14—Orchard well sprayed with lime-sulphur wash.

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